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JUL 78 J W HEADLEY F33615-77-C-3062
UNCLASSIFIED NOR-78-69-VOL-2 AFFDL-TR-78-94-VOL-2 NL

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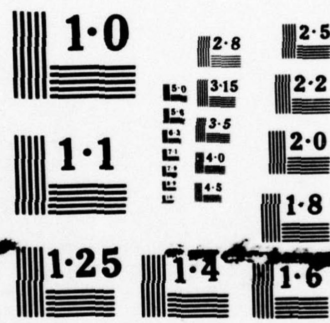

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AFFDL-TR-78-94
VOLUME II

A069646

ANALYSIS OF WIND TUNNEL DATA PERTAINING TO HIGH ANGLE-OF-ATTACK AERODYNAMICS

VOLUME II — Data Base

J. W. Headley

NORTHROP CORPORATION AIRCRAFT GROUP
HAWTHORNE, CALIFORNIA

JULY 1978

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AIR FORCE FLIGHT DYNAMICS LABORATORY
AIR FORCE SYSTEMS COMMAND
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20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This volume presents, in summary form, the geometric and aerodynamic data used as a basis for the design guidelines presented in Volume I. The summaries have been divided into eight sections, the first seven being the low speed tests, which include almost all the configuration development studies and most of the high AOA testing. Data summaries for the transonic and supersonic testing form the eighth and last section. Because of the considerable quantity of data available from all the testing (some test reports containing as much as thirteen volumes), it is not practical to include the sum- over

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maries in all the basic aerodynamic data available. In general, only the main aerodynamic effects are presented or summarized, and for more detailed information on a particular configuration, reference should be made to the actual wind tunnel report. All the data summaries are presented in a similar way, and include the following information:

A data sheet including the test report title, a summary of the report, and the test conditions;

A general three view of a representative test model configuration;

Detailed sketches of the pertinent configurations changes; and

The relevant aerodynamic data.

FOREWORD

This report, "Analysis of Wind Tunnel Data Pertaining to High Angle-of-Attack Aerodynamics" provides a technical discussion and analysis of wind tunnel data obtained from tests conducted on a family of Northrop fighter aircraft. These tests were conducted mainly in the Northrop low speed wind tunnel, during the time period between 1966 and 1976. This report concentrates on data in the stall/post-stall region, and for convenience is provided in two volumes. Volume I, "Technical Discussion and Analysis of Results" presents the data analysis, and from this analysis derives some general guidelines for use during the design of future fighter aircraft operating in the high angle of attack regime. This volume, Volume II "Data Base" contains summaries of the wind tunnel tests which were selected to provide data for the analysis of Volume I. The various wind tunnel test summaries include details of the test programs, model configurations and test data obtained.

This report was prepared by the Northrop Corporation, Aircraft Group, Hawthorne, California, under United States Air Force Contract F33615-77-C-3062. The program was administered by the Air Force Flight Dynamics Laboratory, Air Force Systems Command, Wright-Patterson Air Force Base, Ohio. The project engineer was R. F. Osborne (AFFDL/FXM).

The contract work was performed during the period June 1977 to April 1978. The draft of this report was submitted in April 1978.

The author acknowledges his gratitude to O. R. Edwards and W. A. Moore for assistance during the preparation of this volume.

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SECTION 1

INTRODUCTION

This volume presents, in summary form, the geometric and aerodynamic data used as a basis for the design guidelines presented in Volume I. The summaries have been divided into eight sections, the first seven being the low speed tests, which include almost all the configuration development studies and most of the high AOA testing.

Data summaries for the transonic and supersonic testing form the eighth and last section. These high speed tests, because of cost and scheduling considerations, tend to be of a much more formal nature, and are mainly concerned with obtaining performance data for a given developed configuration. There is also less emphasis on high AOA effects, and more on drag measurements (which tends to be of a secondary nature during the low speed tests).

Because of the considerable quantity of data available from all the testing (some test reports containing as much as thirteen volumes), it is not practical to include the summaries in all the basic aerodynamic data available. In general, only the main aerodynamic effects are presented or summarized, and for more detailed information on a particular configuration, reference should be made to the actual wind tunnel report

All the data summaries are presented in a similar way, and include the following information.

- **A data sheet including the test report title, a summary of the report, and the test conditions.**
- **A general three view of a representative test model configuration.**
- **Detailed sketches of the pertinent configurations changes.**
- **The relevant aerodynamic data.**

Terminology

Reference is made in these summaries, to certain model components and component areas. These are discussed together with other test nomenclature, in the following paragraphs on terminology.

- **Wing Leading Edge Extension**

  The wing surface placed in the area of the wing leading edge and fuselage junction is referred to in several ways, the "wing root horn," "wing strake," "forebody strake," "leading edge root extension (LERX)," and "leading edge extension (LEX)." These various names have been used indiscriminately in the literature. For this report, however, "LEX' will be used to describe this surface, and "strake" will be used to reserve for any narrow quasi-constant chord surface on the forebody, either attached or separate from the LEX. These terms are then consistent with the terminology used in Northrop's Wind Tunnel reports mentioned throughout this study. Figure 1 illustrates these definitions.

- **Wing Area (S_W)**

  The theoretical wing area is always used for the reference area and does not include the LEX area. Figure 1 shows a typical wing.

- **Wind Tunnel Model Configurations**

  Each model component is defined by a letter and number, i.e., wings are W with a chronologically assigned number. Any specific configuration of the model is only defined by the sum of its component ID's, i.e., X W2 H3 V1 B2 C5..., etc., and not by a single definition. Each new project has its own nomenclature, hence wing W2 on the P-530 is not wing W2 on the F-5F, but some flexibility exists here if the same basic model is used for more than one project.

Aerodynamic Data Presentation

- **$C_{L_{MAX}}$**

  When test data are presented for complete airplane configurations, $C_{L_{MAX}}$ effects are given as trimmed values for a C. G. location of 25% M. A. C.

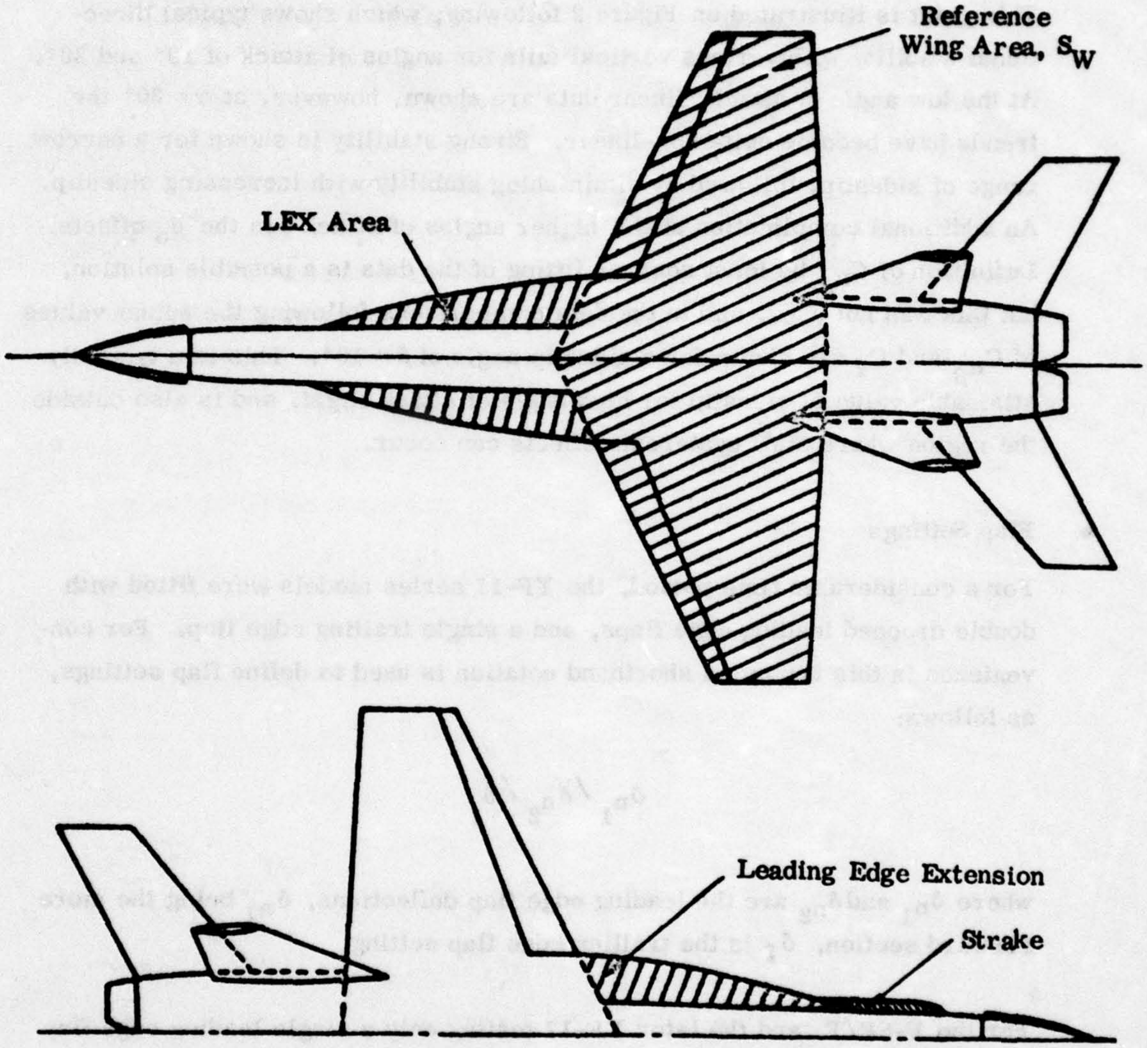


Figure 1. Component Terminology

- Sideslip Data

Sideslip data is mainly presented in the data base in terms of the actual yawing and rolling moments for a given sideslip angle, rather than as the derivatives, which are difficult to define in the high angle of attack region. This point is illustrated on Figure 2 fo' wing, which shows typical directional stability with various vertical tails for angles of attack of 10° and 30°. At the low angle of attack, linear data are shown, however, at $\alpha = 30°$ the trends have become quite non-linear. Strong stability is shown for a narrow range of sideslip, followed by diminishing stability with increasing sideslip. An additional complication at the higher angles of attack are the β_o offsets. Definition of C_{n_β} by least squares fitting of the data is a possible solution, but this was not used, and in the data comparisons following the actual values of C_{n_β} and C_ℓ are shown for a sideslip angle of $\beta = 10°$. This is a typically attainable value of sideslip for high angle of attack flight, and is also outside the region where stall hysteresis effects can occur.

- Flap Settings

For a considerable time period, the YF-17 series models were fitted with double drooped leading edge flaps, and a single trailing edge flap. For convenience in this report, a shorthand notation is used to define flap settings, as follows:

$$\delta_{n_1} / \delta_{n_2} / \delta_f$$

where δ_{n_1} and δ_{n_2} are the leading edge flap deflections, δ_{n_1} being the more forward section, δ_f is the trailing edge flap setting.

For the F-5E/F, and the later YF-17 testing only a single leading edge flap deflection is used, plus a trailing edge flap, so flap settings are defined as δ_n/δ_f.

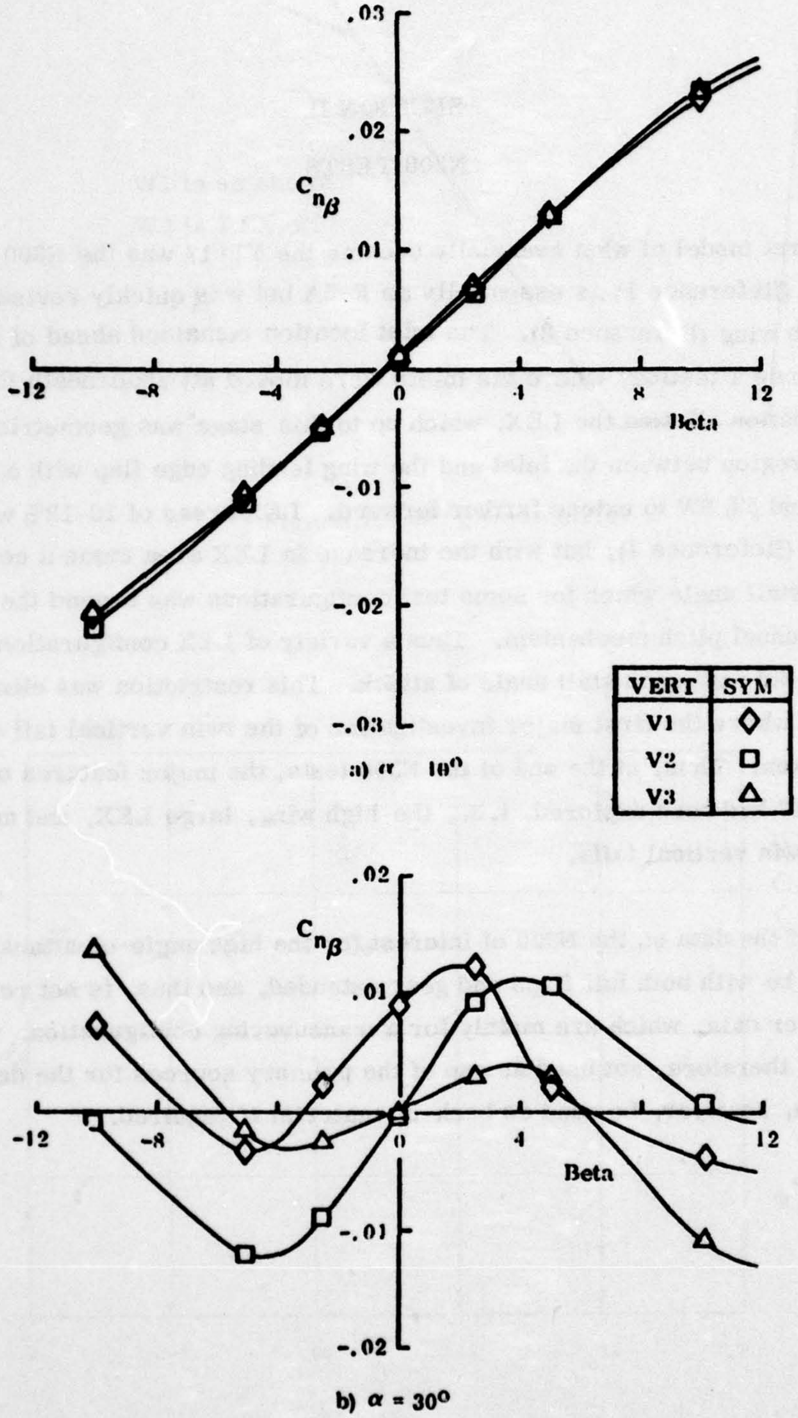


Figure 2. Effect of Angle of Attack on Sideslip Data
for Various Vertical Tails

SECTION II

N300 TESTS

The first model of what eventually became the YF-17 was the N300 configuration, which began (Reference 1) as essentially an F-5A but was quickly revised to incorporate a high wing (Reference 2). The inlet location remained ahead of the wings until Reference 4 testing, where the inlets were moved aft underneath the wings. This modification allowed the LEX, which up to this stage was geometrically confined to the region between the inlet and the wing leading edge flap with a maximum area of around 5% SW to extend farther forward. LEX areas of 10-12% were quickly investigated (Reference 4), but with the increase in LEX area came a corresponding increase in stall angle which for some test configurations was beyond the capability of the wind tunnel pitch mechanism. Thus a variety of LEX configurations which were investigated did not reach stall angle of attack. This restriction was eliminated for Reference 7 where the first major investigation of the twin vertical tail concept was undertaken. Thus, at the end of the N300 tests, the major features of the forthcoming YF-17 had been explored, i.e., the high wing, large LEX, and underwing inlets, and twin vertical tails.

Most of the data on the N300 of interest for the high angle-of-attack data study was found to be with both full flaps and gear extended, and thus, is not really compatible with later data, which are mainly for a maneuvering configuration. The N300 test data is, therefore, not used as one of the primary sources for the design guidelines. It can, however, be used as back-up material if required.

AIRCRAFT	N300	REFERENCE	1

TEST REPORT

NOR 67-57 — Data Report of a Low Speed Wind Tunnel Test to Investigate the Effect of Wing Taper Ratio and of High Lift Systems for the N300 Airplane
F. W. Pietzman

REPORT SUMMARY

This report presents force and moment coefficient data for a low speed development wind tunnel test for the N300 Airplane. The test program was conducted during the period from 7 to 14 June 1966.

The objectives of the test were to investigate the effect of wing taper ratio and high lift systems for the N300 Airplane.

TEST CONDITIONS

Mach No. = 0.15
R. N./Foot = 1.05×10^6
A. O. A. Range = 0 to 28°
Sideslip Range = 0

AIRCRAFT CONFIGURATION

Sketches of configuration changes applicable to this study are shown in Figure 4.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 5 shows the effect on $C_{L_{MAX}}$ of the following items:

- LEX on wing W44
- Flaps on wing W44
- Taper ratio on wing W44, W45 and W48.

All data were obtained at zero sideslip angle.

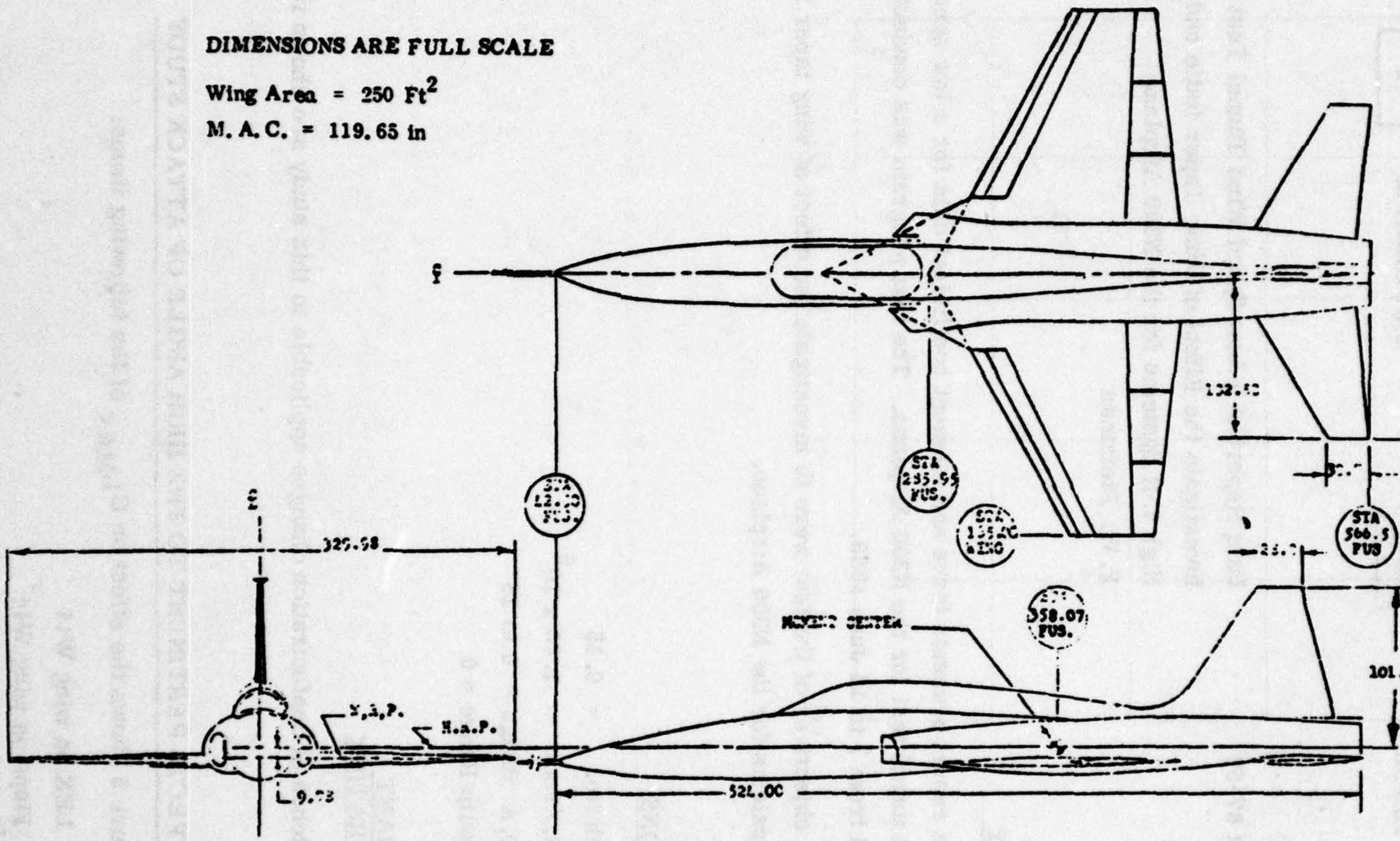


Figure 3. General Three View

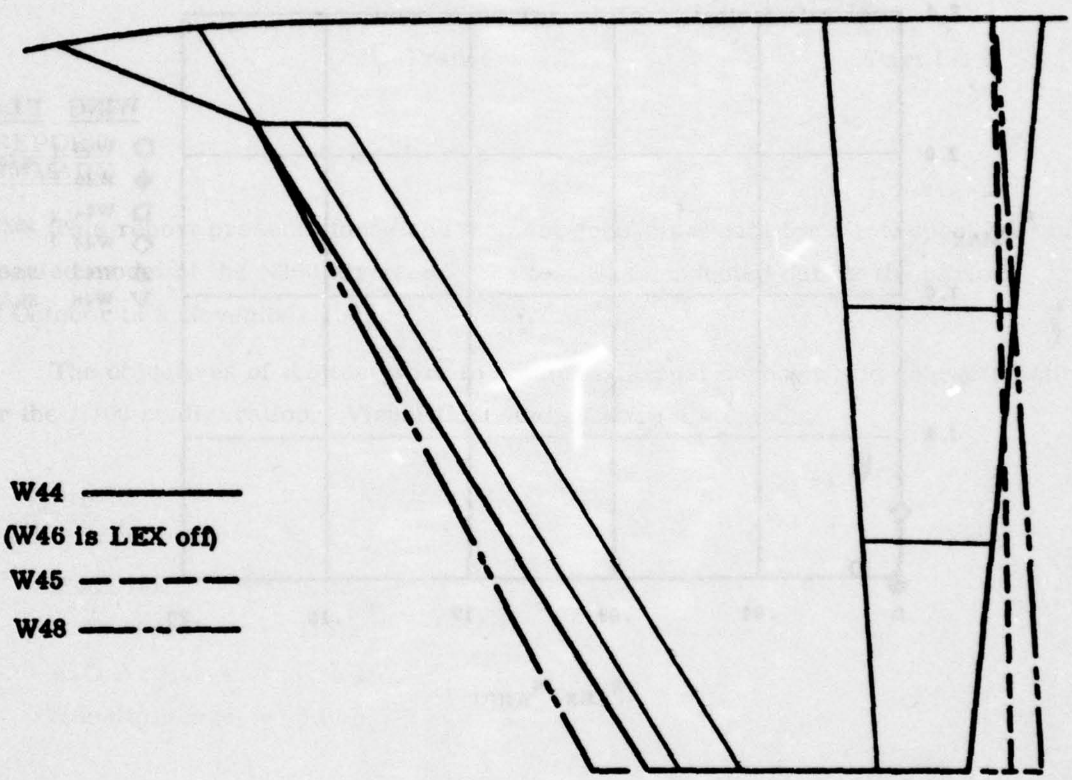


Figure 4. Wing Geometries

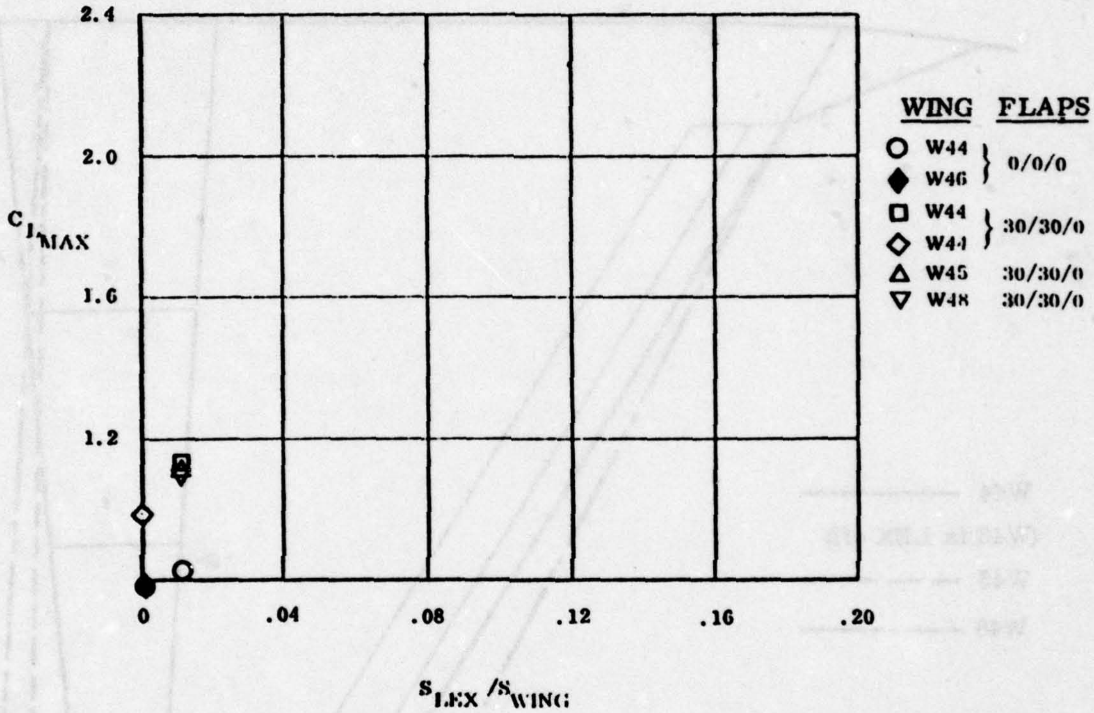


Figure 5. Effect of Flaps, Effect of LEX, Effect of Taper Ratio on $C_{L_{MAX}}$

AIRCRAFT | N300 | **REFERENCE** | 2

TEST REPORT

NOR 67-128 — Data Report of a 1/7 Scale N300 Force Model Low Speed Wind Tunnel Test Project A.
B. Franco — Part I & II

REPORT SUMMARY

This report presents force and moment coefficient data for a low speed wind tunnel test of a 1/7 scale model of the N300 Airplane. The test was conducted during the period 12 December 1966 to 6 January 1967.

The objectives of the test were to obtain aerodynamic characteristics for the N300 configuration providing performance, stability and control data. A secondary objective was to obtain horizontal tail loads data.

TEST CONDITIONS

Mach No. = 0.22
R. N./Foot = 1.3×10^6
A. O. A. Range = 0 to 28°
Sideslip Range = Various

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 6.

CONFIGURATION CHANGES

Sketches of configuration changes applicable to this study are shown in Figure 7. (N300 Nomenclature System)

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 8 shows the effect on $C_{L_{MAX}}$ of the LEX on wing W2 with full flap deflection.

DIMENSIONS ARE FULL SCALE

Wing Area - 250 Ft^2

M.A.C. = 120.13 in

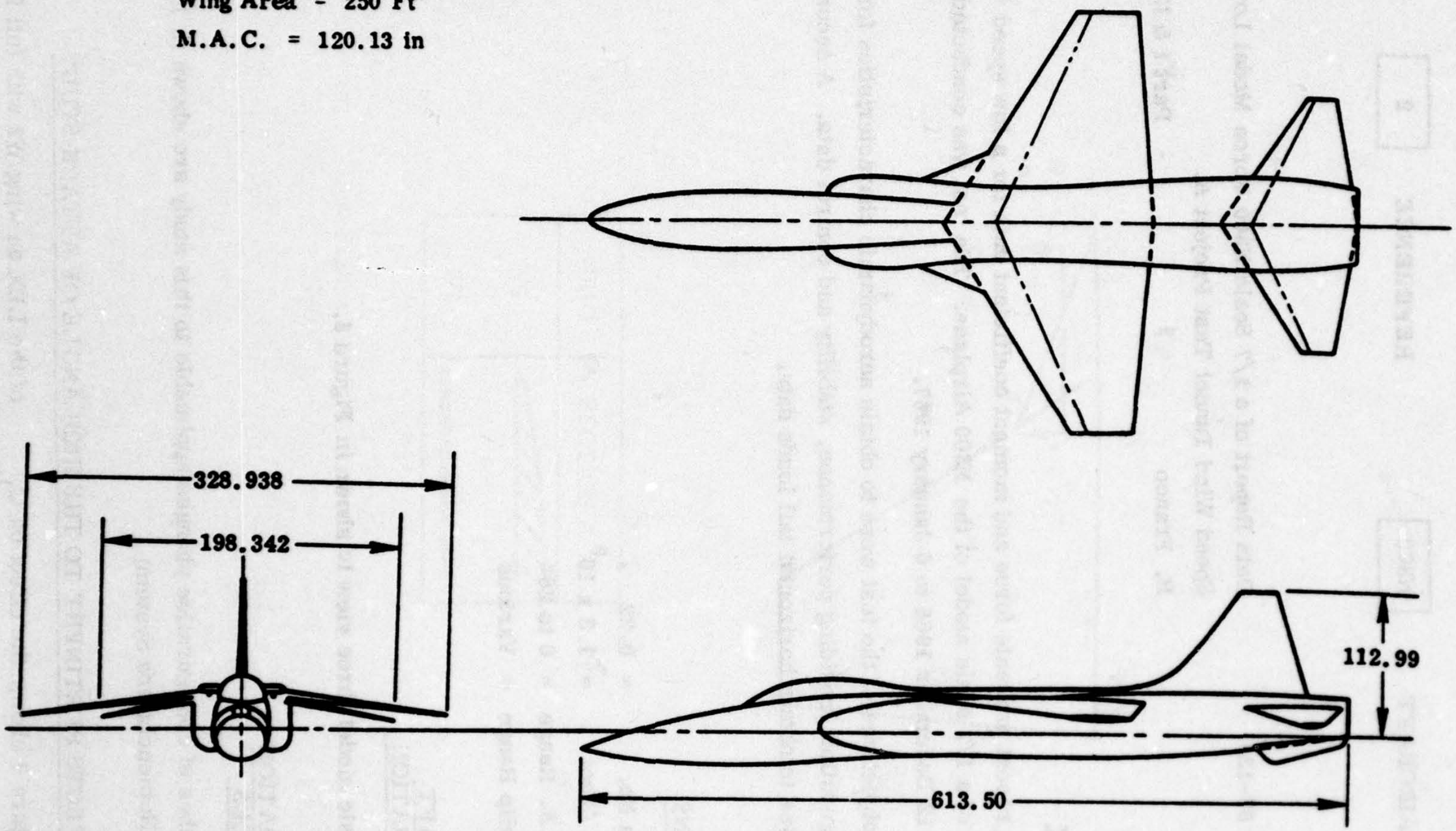


Figure 6. General Three View

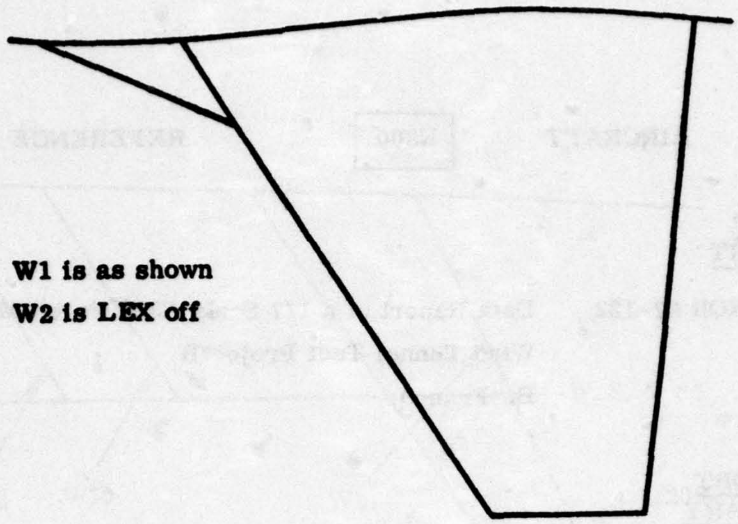


Figure 7. Wing Geometries

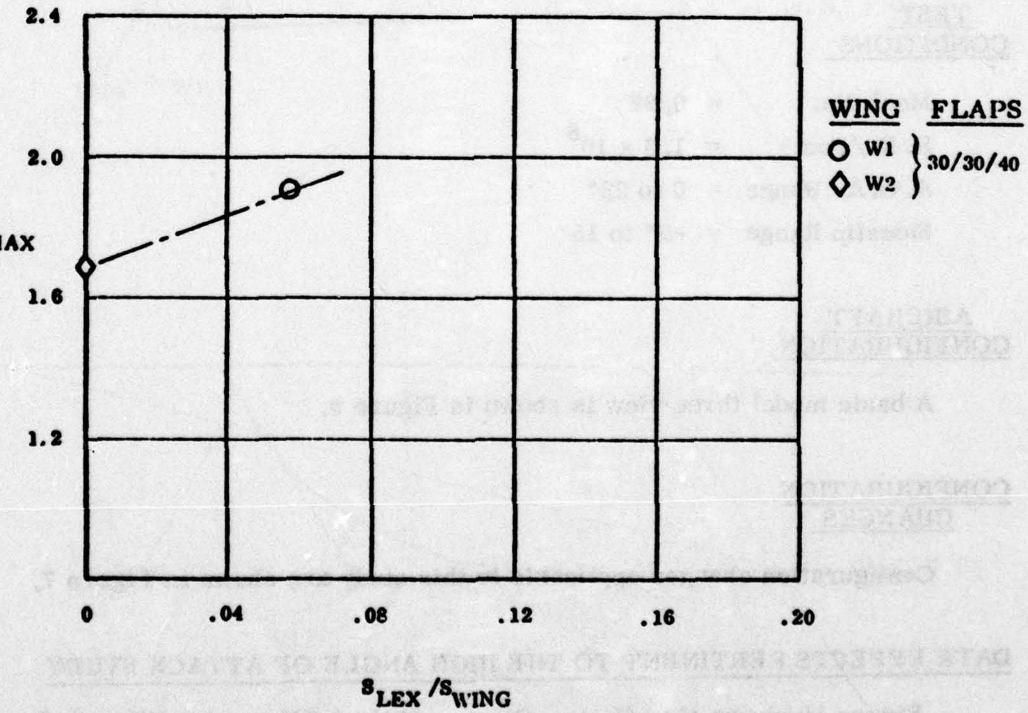


Figure 8. Effect of LEX with Full Flaps on $C_{L_{MAX}}$

AIRCRAFT **N300** REFERENCE **3**

TEST REPORT

NOR 67-132 Data Report of a 1/7 Scale N300 Force Model Low Speed Wind Tunnel Test ProjectB

B. Franco

REPORT SUMMARY

This report presents force and moment coefficient data for a low speed test of a 1/7 scale model of the N300 Airplane. The test program was conducted during the period 27 March 1967 to 31 March 1967.

The objectives of the test were to obtain additional aerodynamic characteristics for the N300 configuration. No horizontal tail loads were measured.

TEST CONDITIONS

Mach No.	=	0.22
R. N./Foot	=	1.3×10^6
A. O. A. Range	=	0 to 28°
Sideslip Range	=	-5° to 15°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 9.

CONFIGURATION CHANGES

Configuration changes applicable to this study are shown in Figure 7.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 10 shows the effect on $C_{L_{MAX}}$ of the LEX on wing W2 with flaps up.

ALL DIMENSIONS ARE FULL SCALE

Wing Area = 250 Ft^2

M.A.C. = 120.13 in

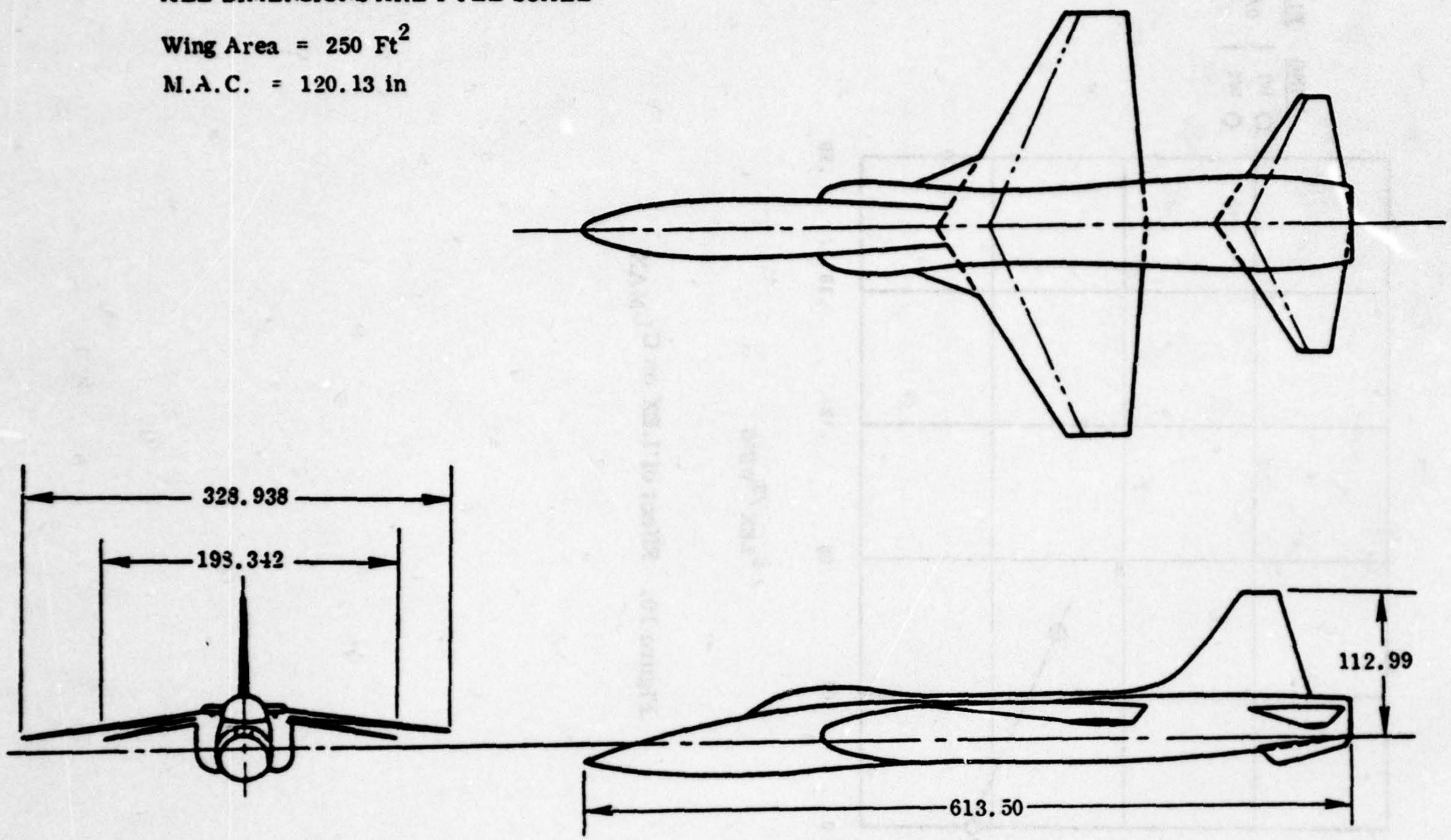


Figure 9. General Three View

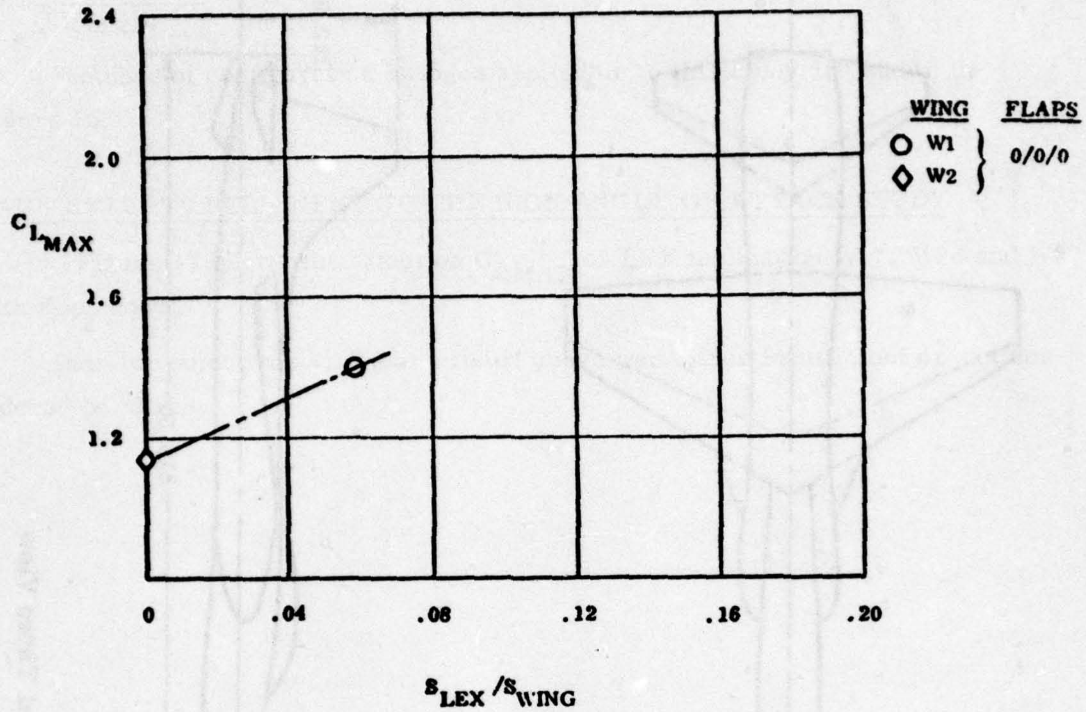


Figure 10. Effect of LEX on $C_{L_{MAX}}$

AIRCRAFT **N300** REFERENCE **4**

TEST REPORT

NOR 68-015 — A Data Report of a Scaled N300 Force Model Low Speed Wind Tunnel Test Project C-1

B. Franco — Part I & II

REPORT SUMMARY

This report presents force and moment coefficient data for a low speed test of a scaled model of the N300 airplane. The test was conducted during the period 23 October to 3 November 1967.

The objectives of the test were to obtain additional aerodynamic characteristics for the N300 configuration. Visual flow studies were also made.

TEST CONDITIONS

Mach No.	=	0.22
R.N./Foot	=	1.5×10^6
A.O.A. Range	=	0 to 28°
Sideslip Range	=	5 to -15°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 11.

CONFIGURATION CHANGES

Sketches of configuration changes applicable to this study are shown in Figures 12 and 13. Configuration W1 is shown in Figure 7.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 14 shows the effect on $C_{L_{MAX}}$ of the following items:

LEX airfoil, W5 and W7 with flaps down and W5, flaps up.

LEX planform, W1, W9 through W14 and W16 with flaps down.

LEX planform W8 with flaps up.

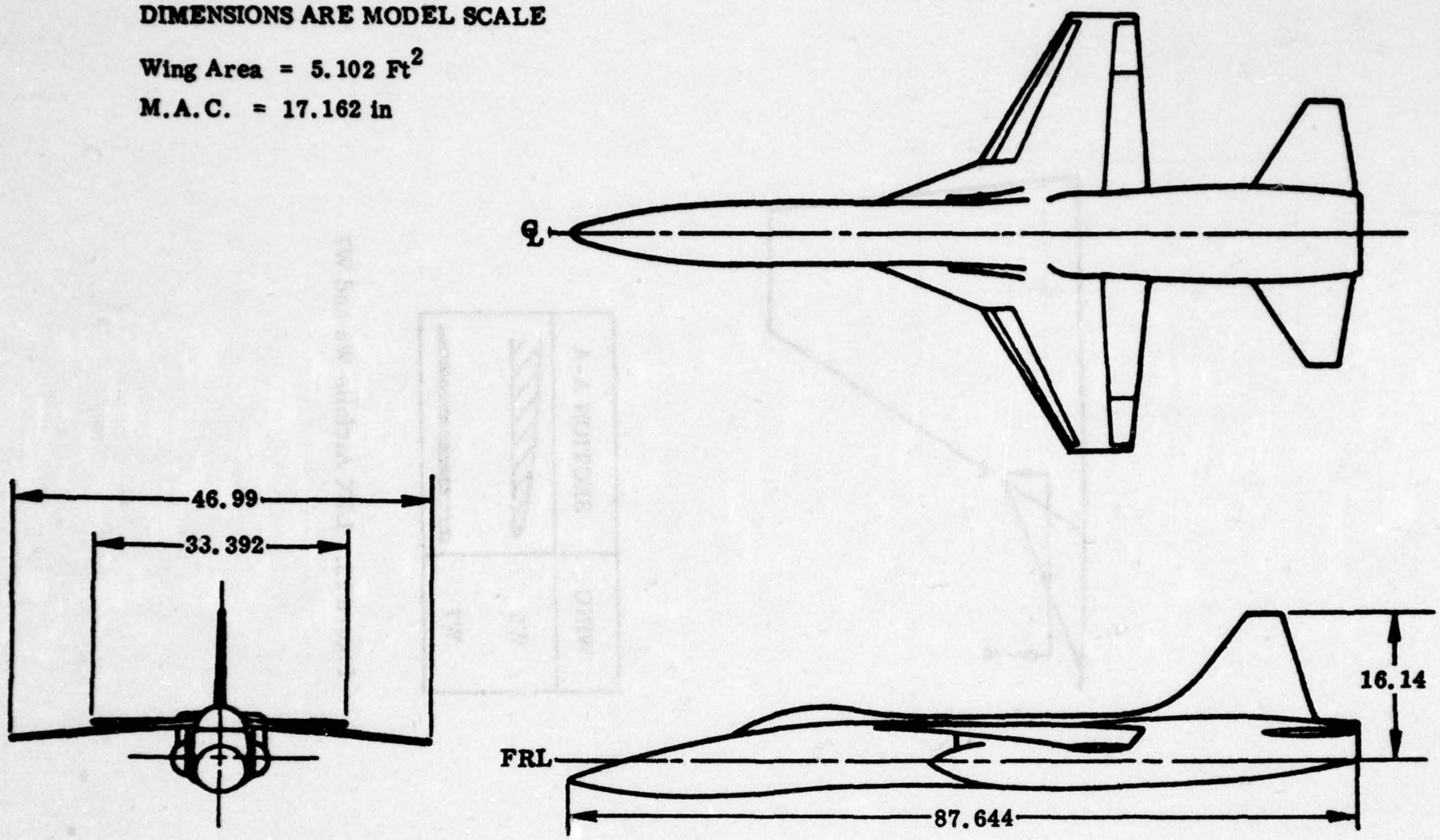


Figure 11. General Three View

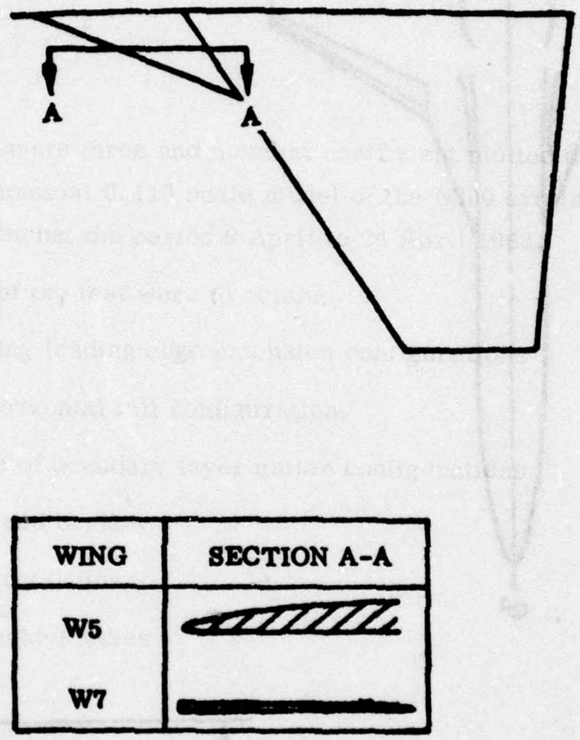


Figure 12. LEX Airfoils W5 and W7

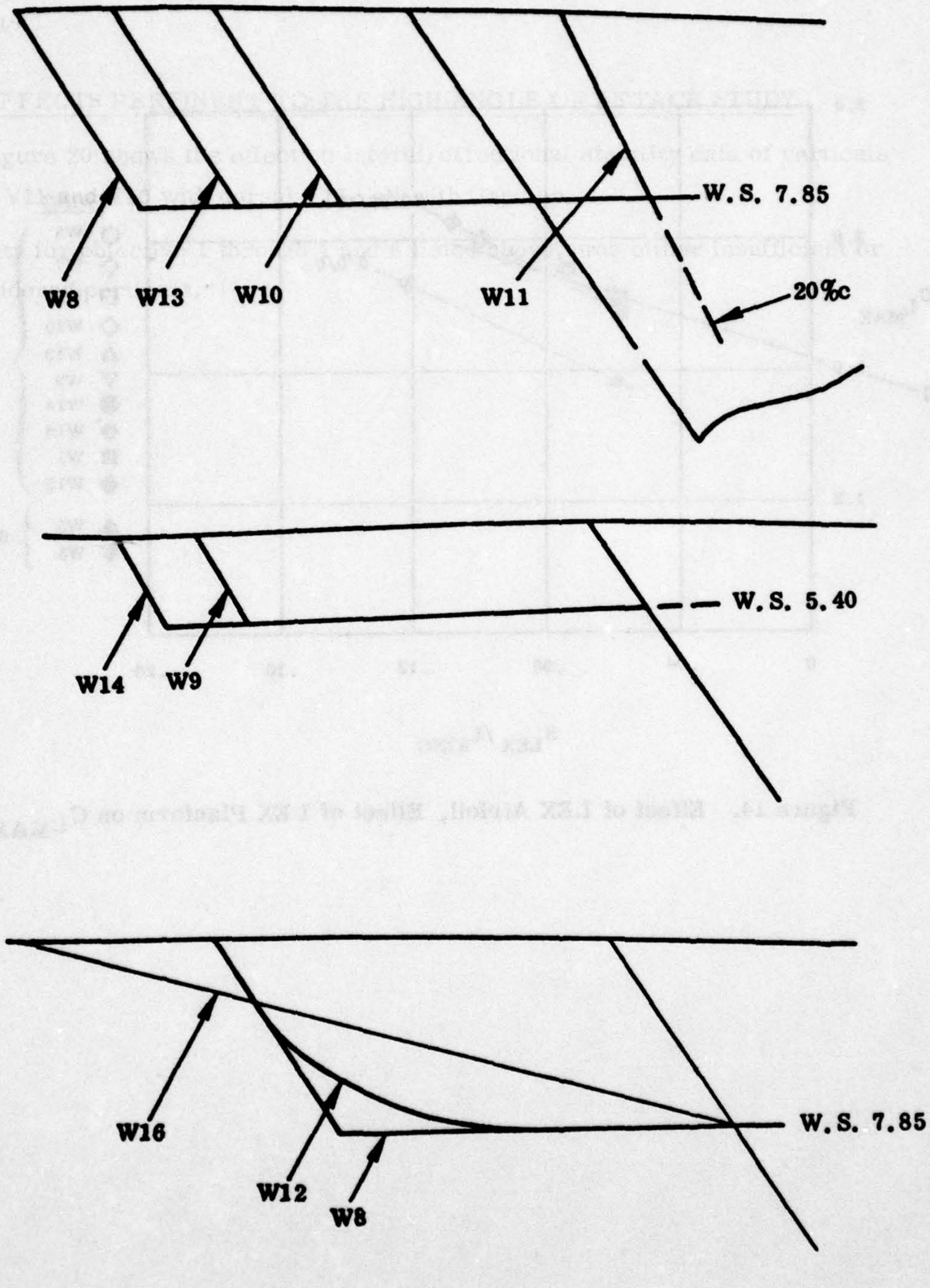


Figure 13. LEX Planforms

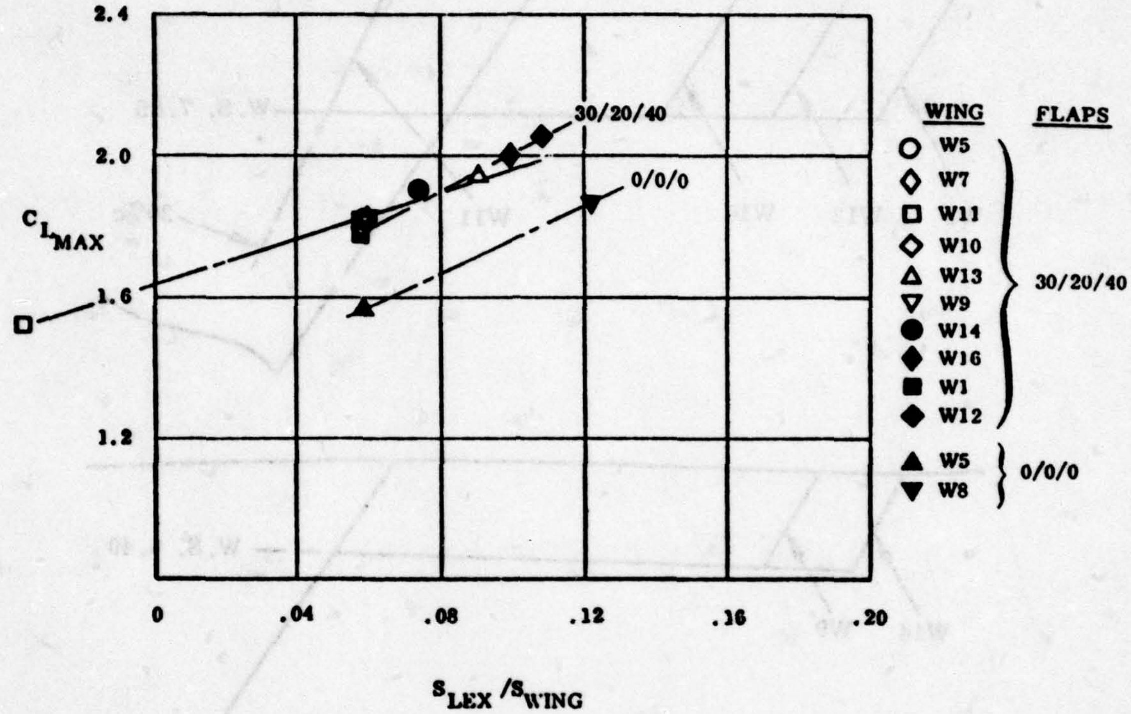


Figure 14. Effect of LEX Airfoil, Effect of LEX Planform on $C_{L_{MAX}}$

AIRCRAFT | N300 | REFERENCE | 5

TEST REPORT

NOR 68-100 — Data Report of a Scaled N300 Force Model Low Speed Wind Tunnel Test Project C-3

B. G. Franco

REPORT SUMMARY

This report presents force, moment and pressure coefficient data for a low speed wind tunnel test of a scaled model of the N300 airplane. The test program was conducted during the period 13 March to 22 March 1968.

The objectives of the test were to obtain:

1. Effect of wing leading edge extension configurations
2. Effect of horizontal tail configuration
3. Comparison of boundary layer gutter configurations
4. Effect of wing trailing edge flaps gap, overhang and shroud angle

TEST CONDITIONS

Mach No. = 0.22

R. N./Foot = 1.4×10^6

A. O. A. Range = -6° to 26°

Sideslip Range = 0°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 15.

CONFIGURATION CHANGES

Sketches of configuration changes applicable to this study are shown in Figure 16.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 17 shows the effect on C_{LMAX} of LEX inclination W17, W26 and W27 with flaps down.

Data for objectives 2, 3 and 4 listed above was either insufficient or not considered pertinent.

DIMENSIONS ARE MODEL SCALE

Wing Area = 5.102 Ft^2

M.A.C. = 17.162 in

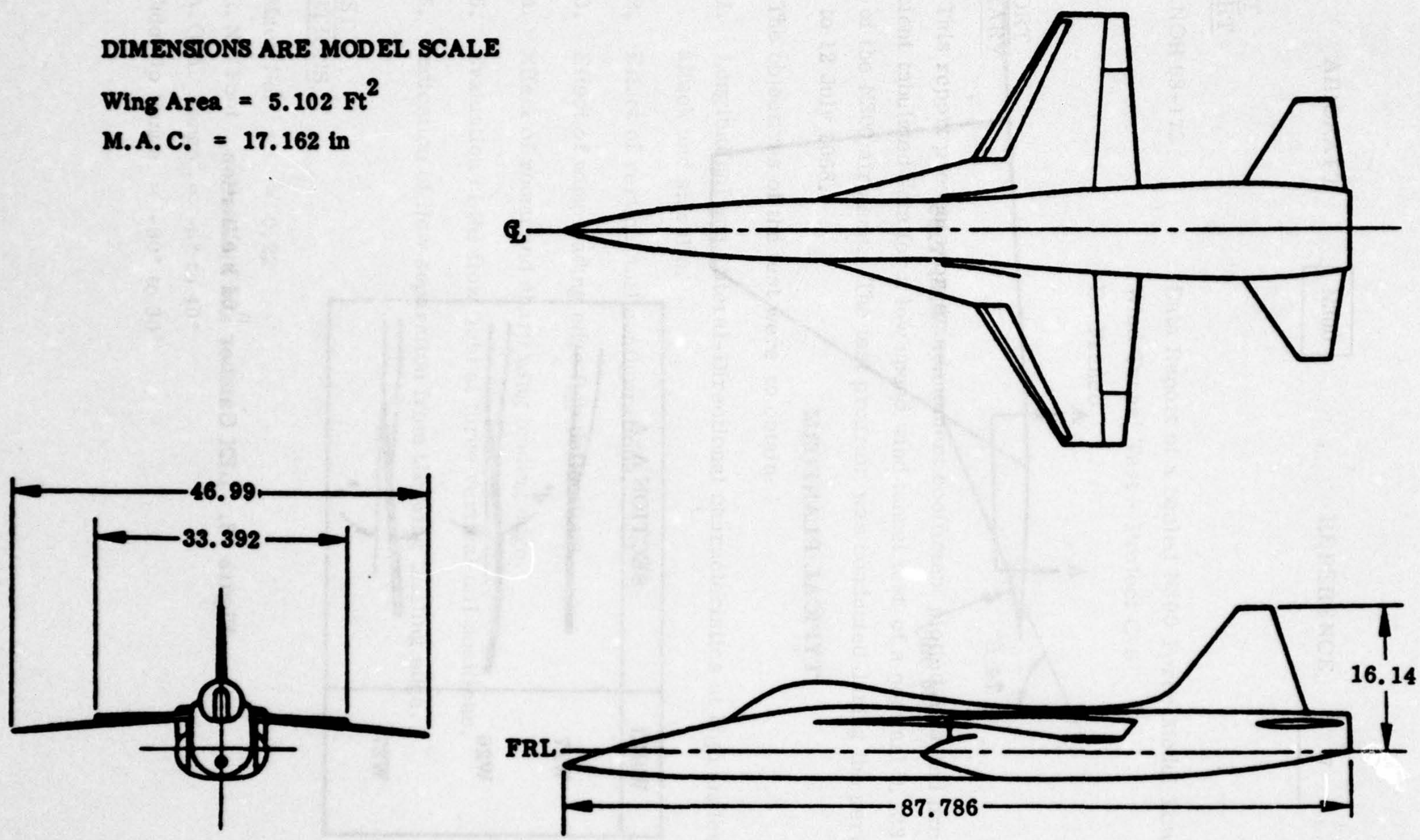


Figure 15. General Three View

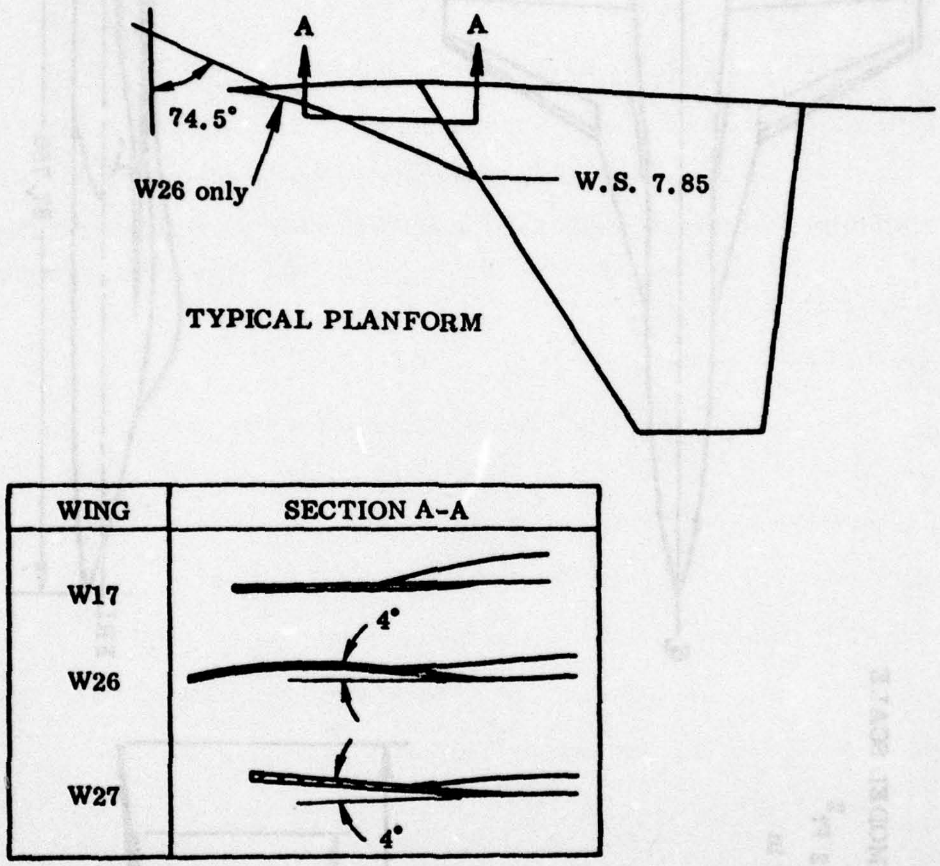


Figure 16. LEX Camber and Inclination

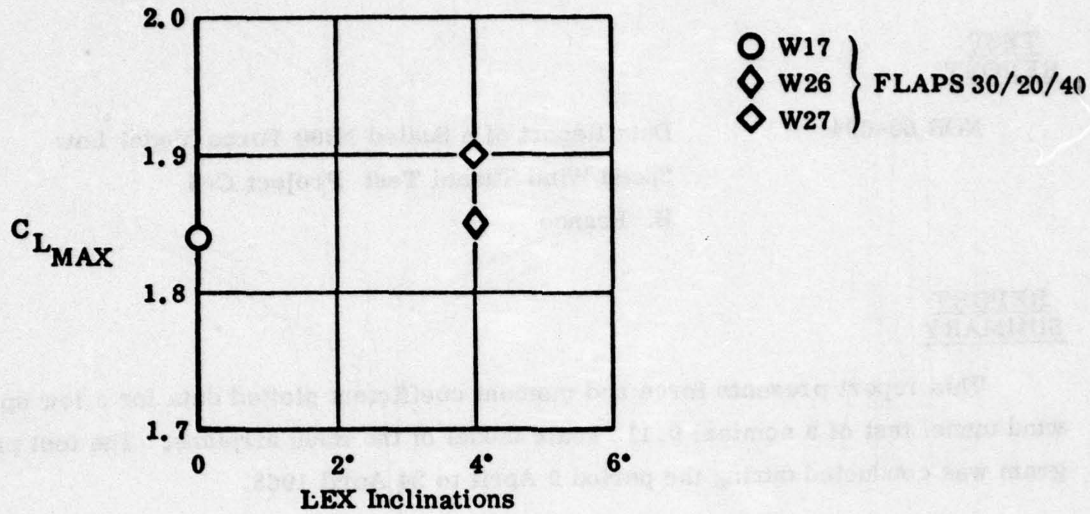


Figure 17. Effect of LEX Inclination

AIRCRAFT | N300 | REFERENCE | 6

TEST REPORT

NOR 68-094 — Data Report of a Scaled N300 Force Model Low Speed Wind Tunnel Test Project C-5

B. Franco

REPORT SUMMARY

This report presents force and moment coefficient plotted data for a low speed wind tunnel test of a nominal 0.113 scale model of the N300 airplane. The test program was conducted during the period 9 April to 24 April 1968.

The objectives of the test were to obtain:

1. Effect of wing leading edge extension configurations
2. Effect of horizontal tail configurations
3. Comparison of boundary layer gutter configurations
4. Effect of speed brakes
5. Effect of ventral fins
6. Tuft and smoke studies

TEST CONDITIONS

Mach No. = 0.22
R. N./Foot = 1.4×10^6
A. O. A. Range = -6° to 26°
Sideslip Range = 20° to -20°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 18.

CONFIGURATION CHANGES

Sketches of configuration changes applicable to this study are shown in Figure 19.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 20 shows the effect on lateral/directional stability data of verticals V10 and V11 and V10 with dorsal F11, all with flaps up.

Data for objective 1 through 4 and 6 listed above, was either insufficient or not considered pertinent.

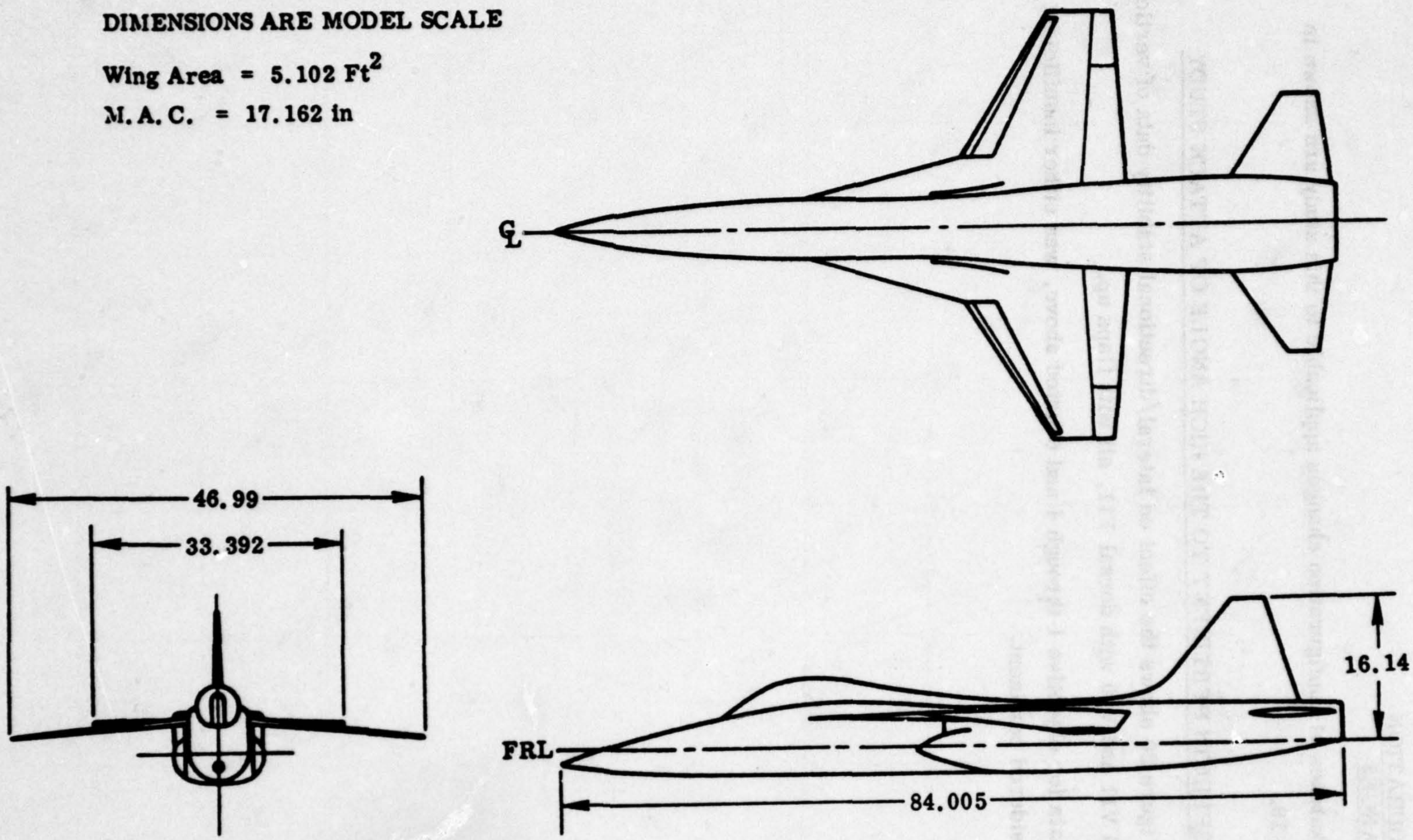


Figure 18. General Three View

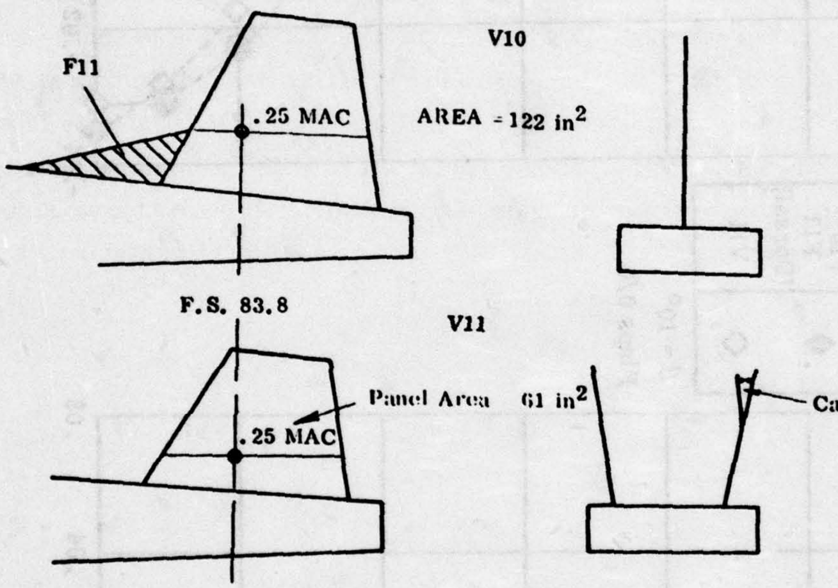


Figure 19. Vertical Tail and Dorsal Geometries

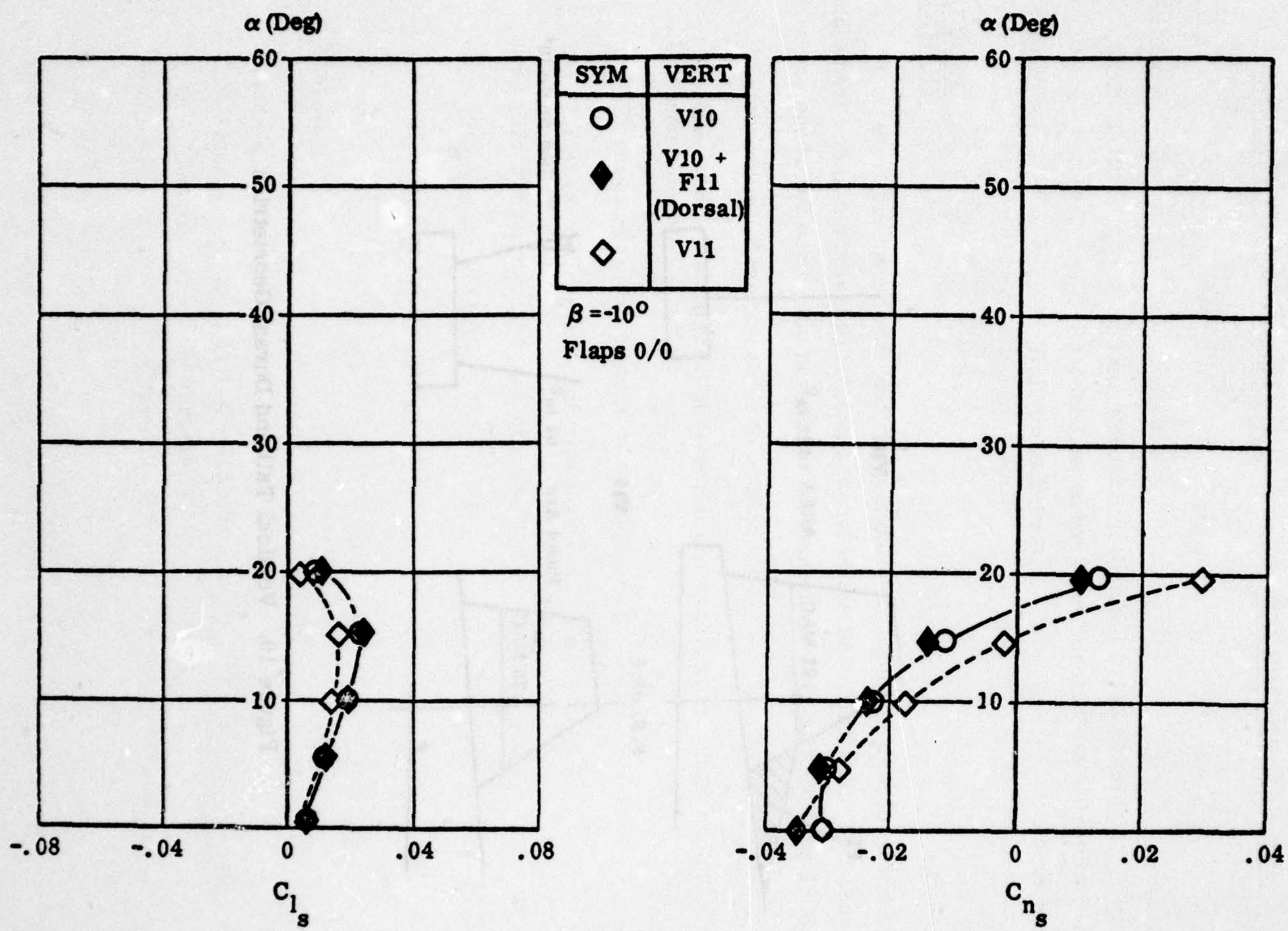


Figure 20. Comparison of Vertical Tails

AIRCRAFT **N300** REFERENCE **7**

TEST REPORT

NOR 68-172 Data Report of a Scaled N300 Force Model Low Speed Wind Tunnel Test - Project C-6

B. Franco

REPORT SUMMARY

This report presents force and moment coefficient plotted data and pressure coefficient tabulated data for a low speed wind tunnel test of a nominal 0.133 scale model of the N300 airplane. The test program was conducted during the period 1 July to 12 July 1968.

The objectives of the test were to obtain:

1. Longitudinal and Lateral-Directional characteristics at high angles of attack and sideslip.
2. Effect of vertical tail configurations.
3. Effect of wing leading edge flap deflections.
4. Effect of round and sharp wing leading edge.
5. Evaluation of the flow field at three vertical tail positions.
6. Indication of flow separation from the wing trailing edge.

TEST CONDITIONS

Mach No.	=	0.22
R.N./Foot	=	1.4×10^6
A.O.A. Range	=	$-6°$ to $40°$
Sideslip Range	=	$-30°$ to $30°$

AIRCRAFT CONFIGURATION

A basic model three viewis shown in Figure 21.

CONFIGURATION CHANGES

Sketches of configuration changes applicable to this study are shown in Figure 22.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 23 shows lateral/directional stability data, flaps down, for wing W35 with verticals V14, V18, V22, V25 and without a vertical.

Data for objectives 1 and 3 through 6 listed above was either insufficient or not considered pertinent.

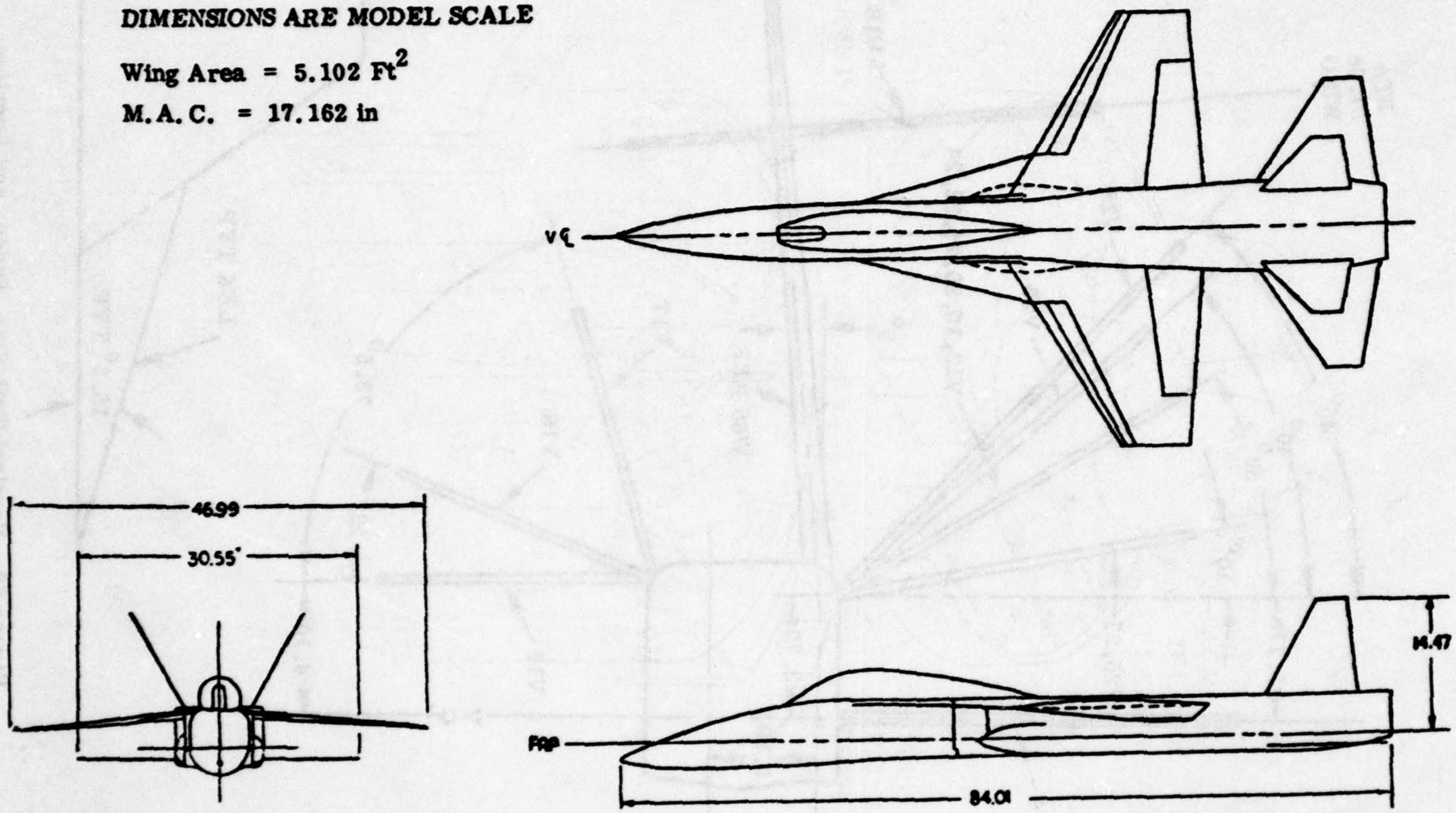


Figure 21. General Three View

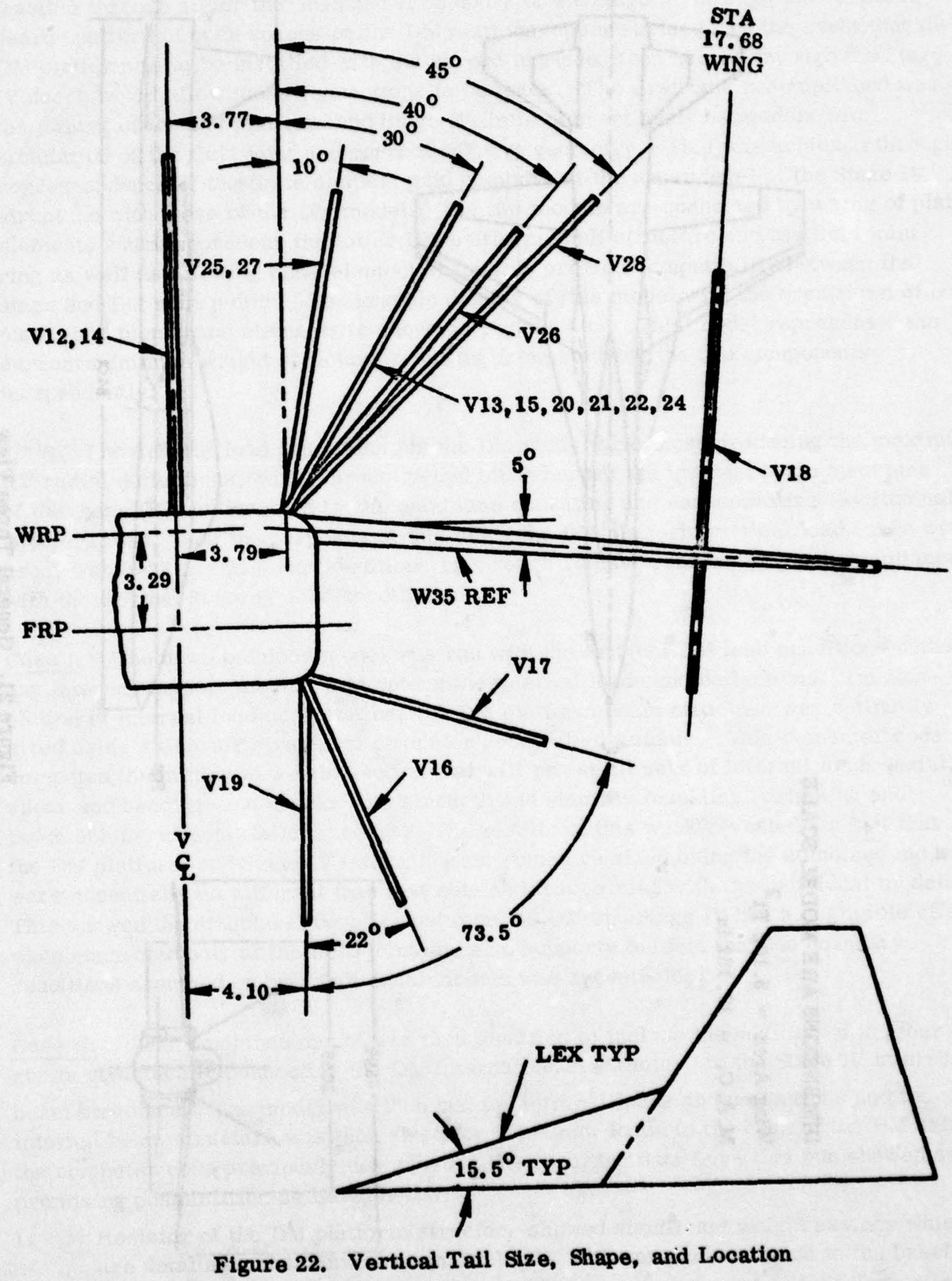


Figure 22. Vertical Tail Size, Shape, and Location

Vertical	Single	Twin	Upper	Lower	Angle From Vert	Aspect Ratio	Vertical Tail Lex	25%$\bar{c}$ Fus Sta	Area Ft^2
V12	X	—	X	—	0^o	1.22	X	83.86	0.845
V13	—	X	X	—	30^o	1.22	X	83.86	0.423
V14	X	—	X	—	0^o	1.22	X	83.86	1.445
V15	—	X	X	—	30^o	1.21	X	83.86	0.714
V16	—	X	—	X	22^o	1.22	—	83.86	0.423
V17	—	X	—	X	73.5^o	1.22	—	83.86	0.423
V18	—	X	X	X	5^o	1.78	X	81.69	0.824
V19	—	X	—	X	0^o	1.22	—	83.86	0.423
V20	—	X	X	—	30^o	1.22	X	83.86	0.423
V21	—	X	X	—	30^o	2.44	X	78.86	0.419
V22	—	X	X	—	30^o	1.72	X	83.86	0.729
V24	—	X	X	—	30^o	1.21	—	83.86	0.714
V25	—	X	X	—	10^o	1.21	—	83.86	0.714
V26	—	X	X	—	40^o	1.21	—	83.86	0.714
V27	—	X	X	—	10^o	1.21	X	83.86	0.423
V28	—	X	X	—	25^o	1.24	—	83.86	1.285

Figure 22. Continued

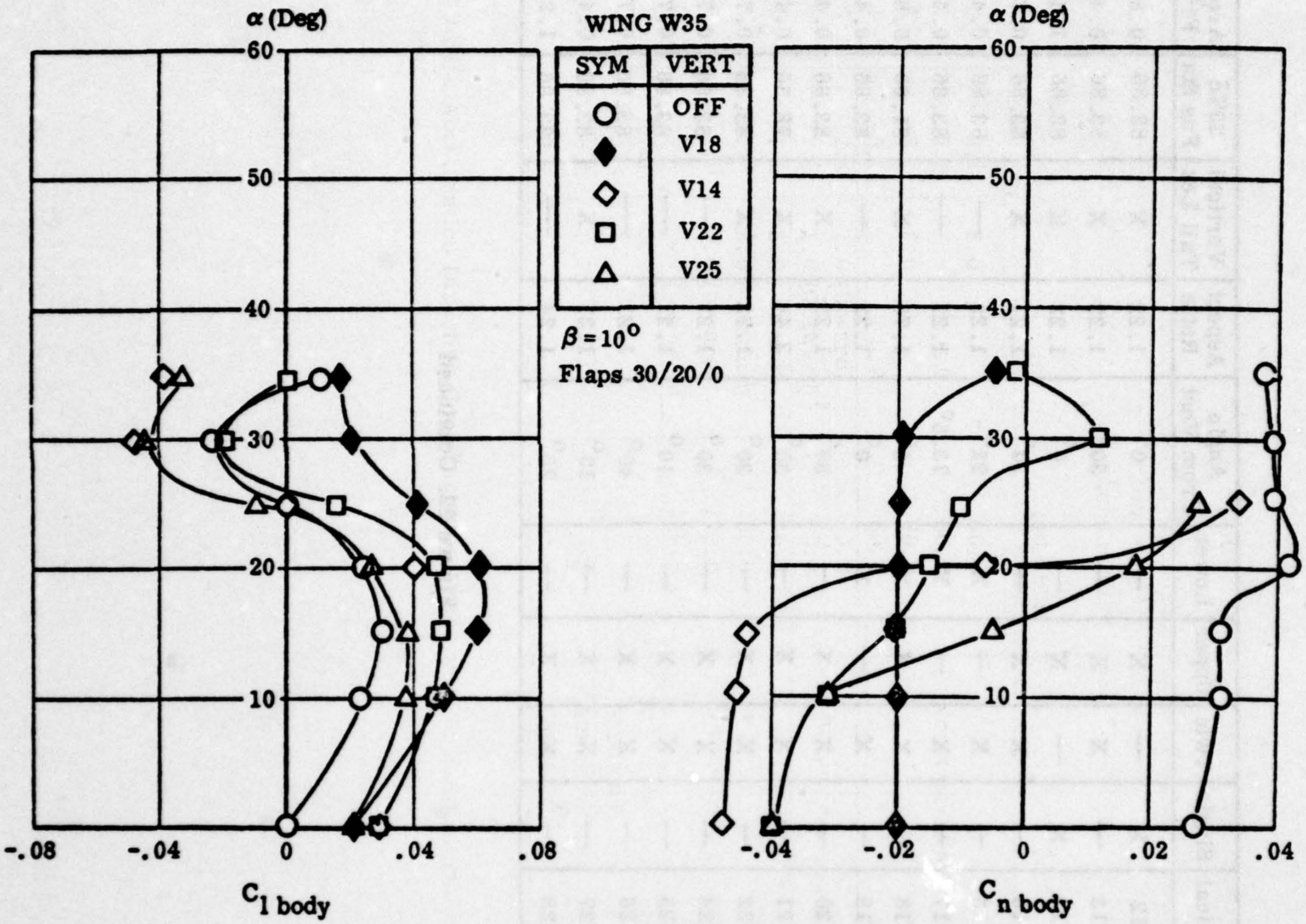


Figure 23. Effect of Various Vertical Tails

SECTION III

P530 TESTS

Low speed wind tunnel testing of the P530 took place between August 1968 and May 1971. The basic configuration remained reasonably constant during this period: a large LEX, 10-15% of the wing area, double drooped leading edge flaps, a moderately swept basic wing, and twin verticals. Testing in the high AOA range was mainly concerned with small variations in LEX planform, cross section, and attitude, plus the effects of small strakes ahead of the LEX. Adoption of the twin vertical concept opened up the test matrix possibilities, so that in addition to assessing the effects of vertical size, shape, and fore and aft location, the effects of vertical lateral spacing and cant angle had to be determined. Hence, a considerable amount of the testing summarized in the following section is concerned with the effects of various verticals and their locations. The effects of LEX variations are also covered.

AIRCRAFT **P530** REFERENCE **8**

TEST REPORT

NOR 69-122	Data Report of a Nominal 0.113 Scale P530 Force Model Low Speed Wind Tunnel Test - Project C-8
	B.J. de la Peurta — Parts 1 to 3

REPORT SUMMARY

This report presents force and moment coefficient plotted data for a low speed wind tunnel test of a nominal 0.113 scale model of the P530 airplane. This test program was conducted during the period from 9 September 1968 to 9 October 1968.

The objectives of the test were to obtain:

1. Longitudinal and lateral-directional characteristics at high angles of attack and sideslip.
2. Effect of wing leading edge extensions
3. Effect of vertical tail configurations
4. Effect of horizontal tail configurations
5. Effect of speed brakes
6. Effect of ventral fin configurations

TEST CONDITIONS

Mach No.	= 0.2 - 0.22
R.N./Foot	= $1.4 - 1.5 \times 10^6$
A.O.A. Range	= Various
Sideslip Range	= Various

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 24.

CONFIGURATION CHANGES

Sketches of LEX configuration changes applicable to this study are shown in Figures 25, 26 and 27. Sketches of vertical tail configuration changes are shown in Figures 29 and 30.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 28 shows the effect on $C_{L_{MAX}}$ of the following items:

LEX airfoil W35 and W40 with flaps up.

LEX cross-section W42, W44 and W45 with flaps 24/15/0.

LEX cross-section W42, W46 and W47 with flaps 40/20/0.

LEX planform W42 and W46 with flaps 40/20/0.

Figure 31 shows the effect on lateral/directional stability of typical vertical tails, V34 and V43 with flaps 40/20/0.

Data for objectives 1, and 4 through 6 listed above was either insufficient or not considered pertinent.

Dimensions are Model Scale

Wing Area = 5.102 Ft^2

M.A.C. = 17.162 in

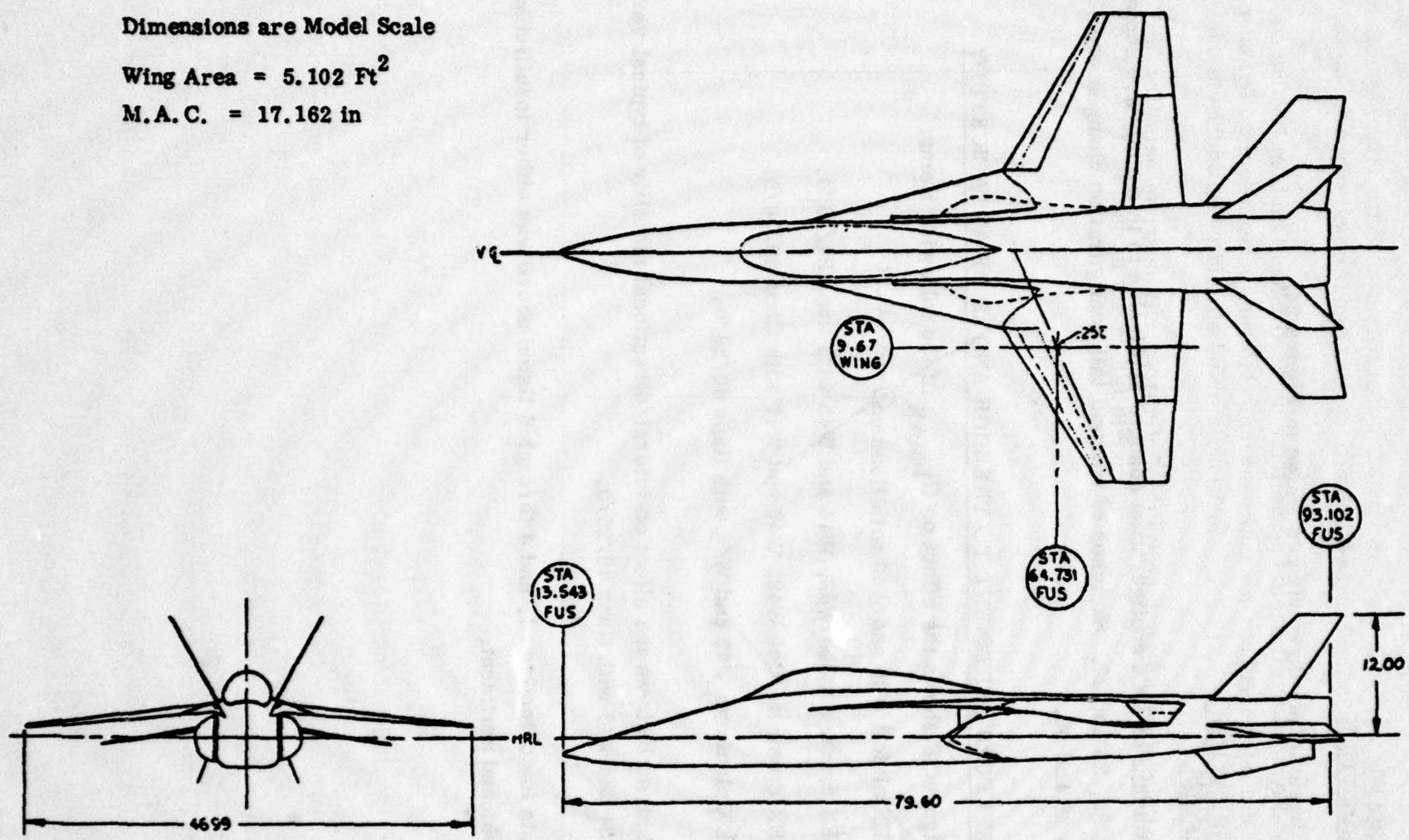


Figure 24. General Three View

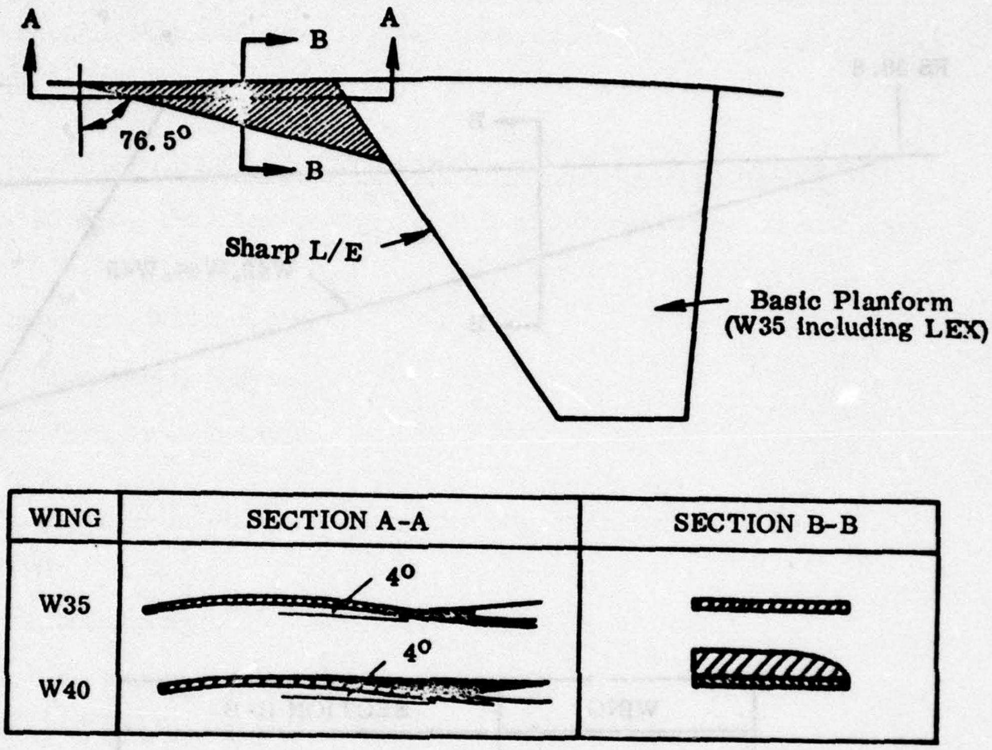


Figure 25. Variation in the LEX Airfoil Shape for a Fixed Planform Geometry

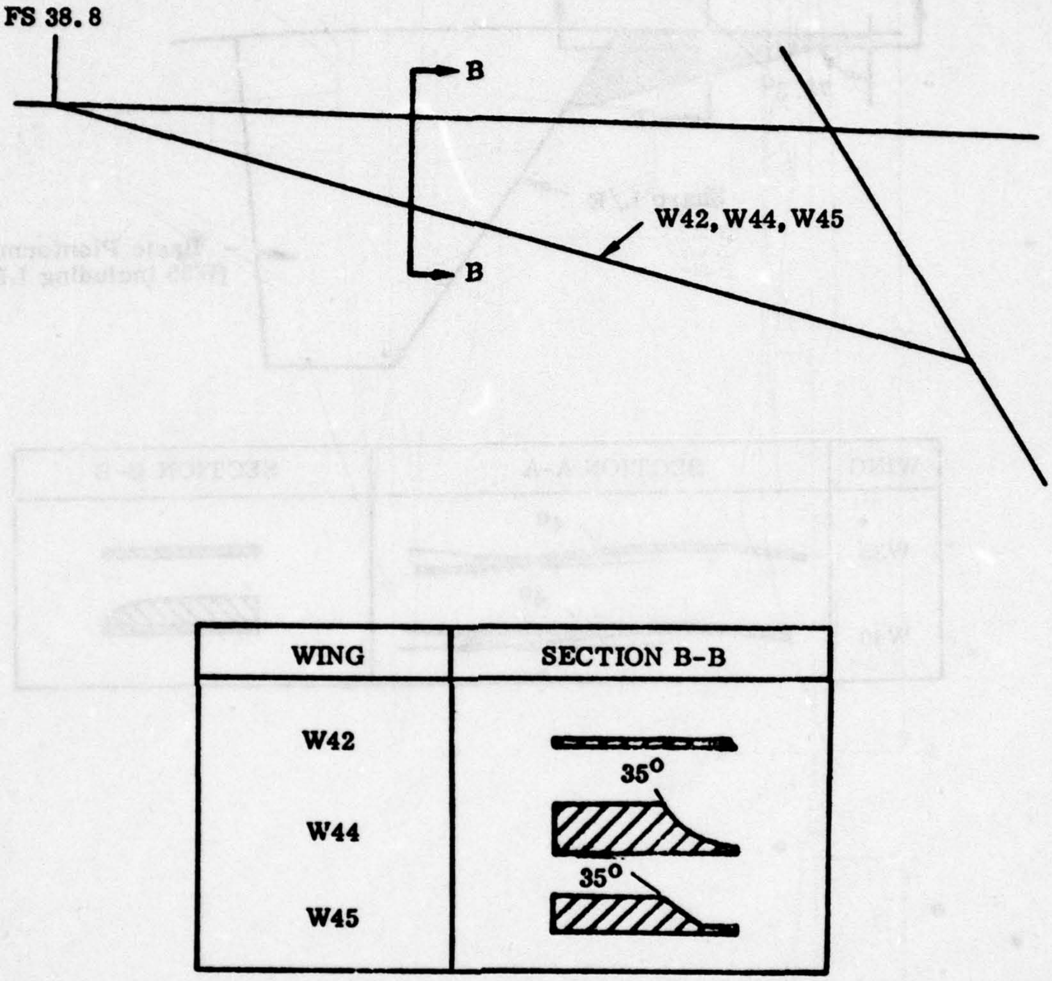
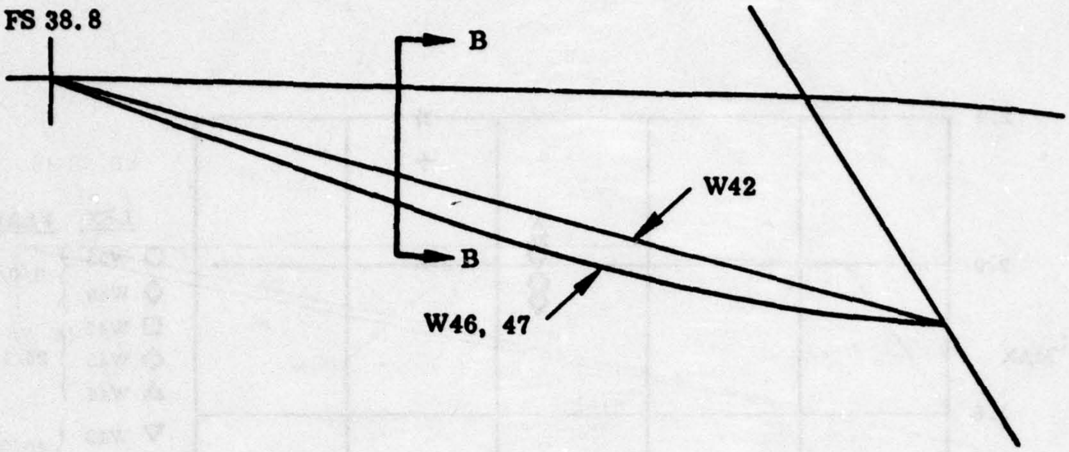


Figure 26. Variation in LEX Cross-Section for a Fixed Planform Geometry



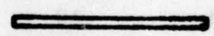
WING	SECTION B-B
W46	
W47	

Figure 27. LEX Cross-Section Variation for a Fixed Planform Shape

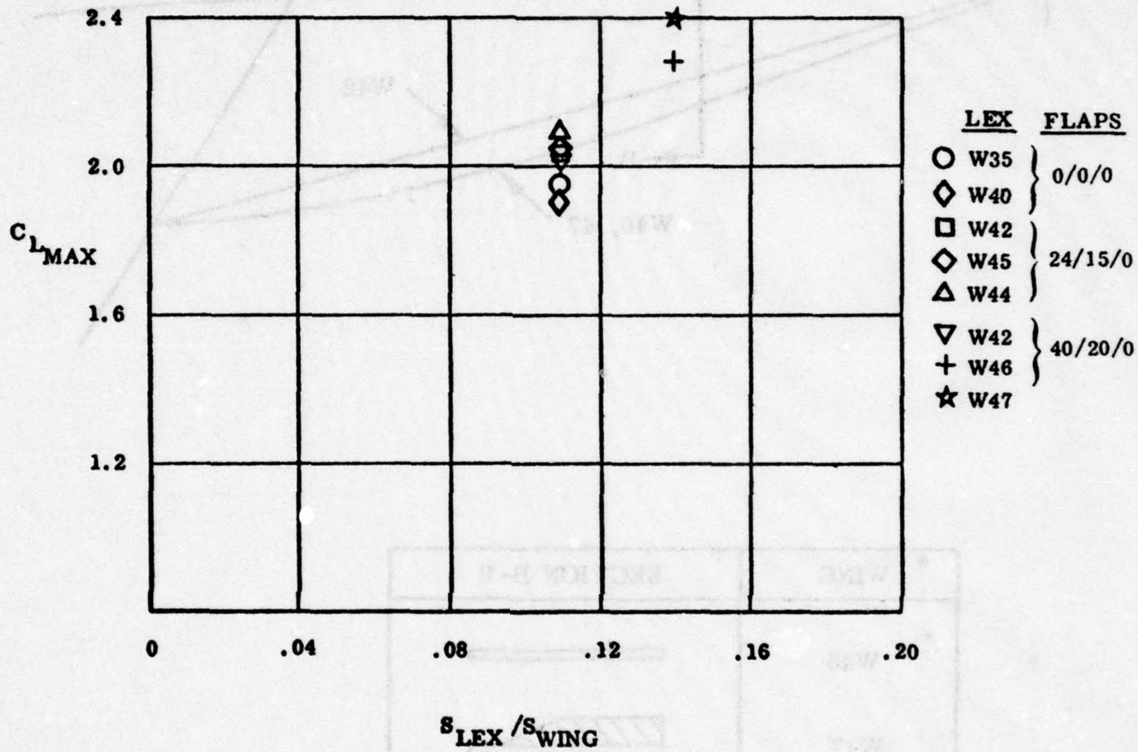


Figure 28. Effect of LEX Geometry Changes on $C_{L_{MAX}}$

VERTICAL	CANT ANGLE	AREA/PANEL SQ. IN.
26	40^{o}	102.81
29 30 31	20^{o} 30^{o} 40^{o}	61.5
32 33	40^{o} 20^{o}	85.5
35 37	30^{o} 20^{o}	106.2
38	20^{o}	61.5
39	30^{o}	61.5
40 41 42 43 44 45	20^{o} 30^{o} 20^{o} 30^{o} 20^{o} 30^{o}	106.25
49 52	30^{o} 10^{o}	87.3
53	30^{o}	61.5

Figure 29. Twin Vertical Tail Configurations Mounted on the Aft Fuselage

VERTICAL	B. L.	CANT ANGLE	AREA/PANEL SQ. IN.
34	7.78	20^{o}	61.5
36	9.47	20^{o}	61.5
46	9.47	0^{o}	61.5
47 48	7.78	0^{o} 20^{o}	61.8
50	7.78	20^{o}	87.3
51	7.78	10^{o}	87.3

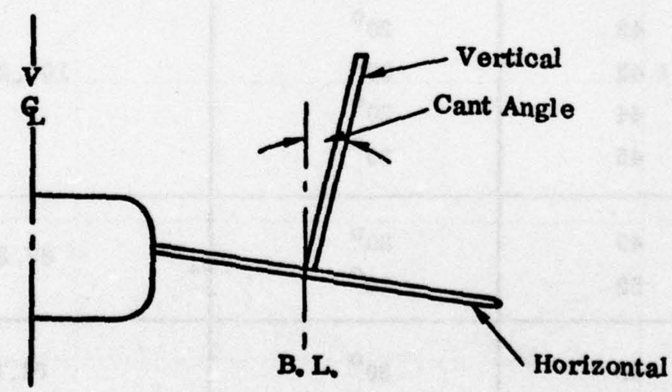


Figure 30. Twin Vertical Tail Configurations Mounted on the Horizontal Tail

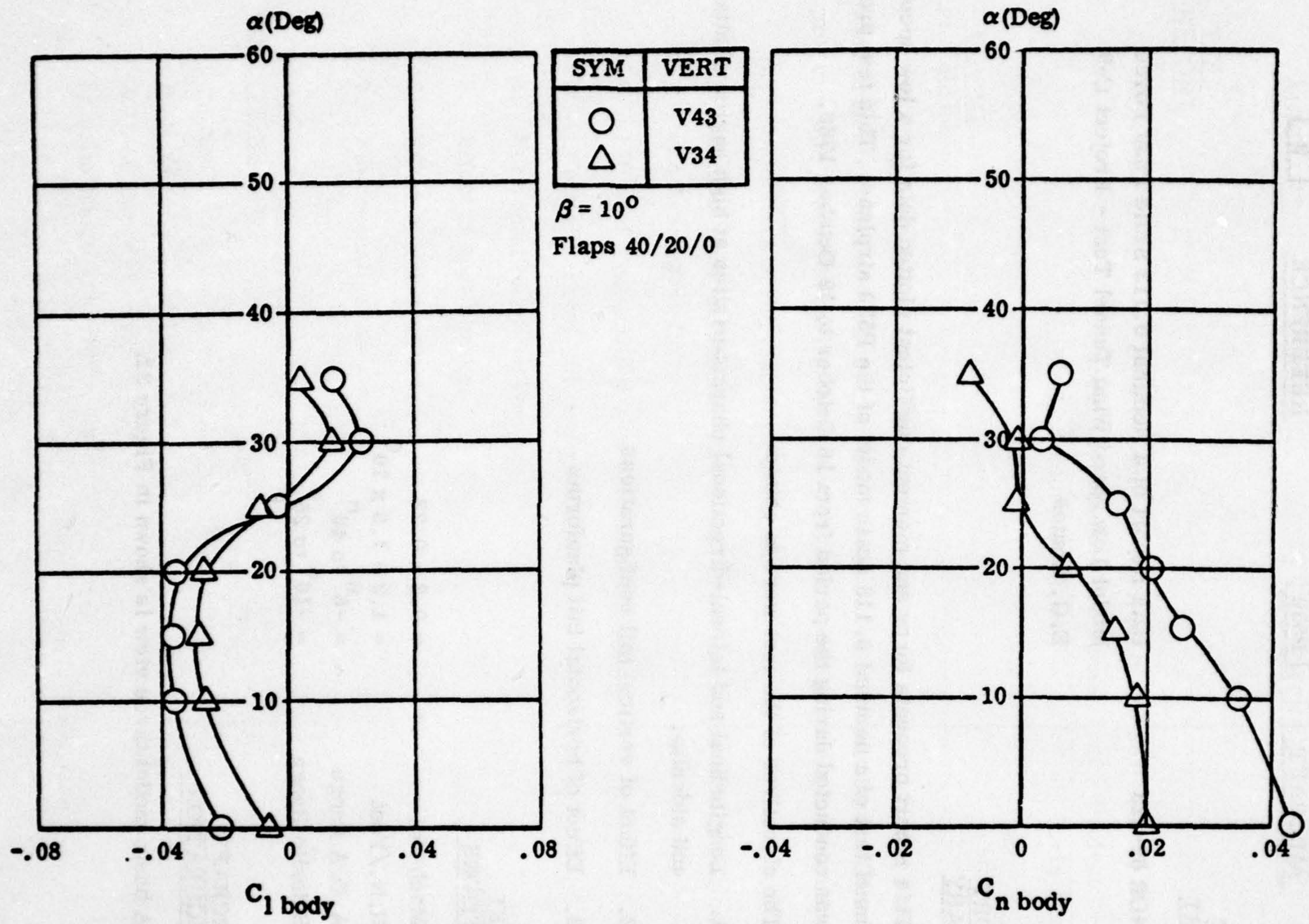


Figure 31. Typical Vertical Tail Data

AIRCRAFT	P530	REFERENCE	9

TEST REPORT

NOR 69-123 — Data Report of a Nominal 0.113 Scale P530 Force Model Low Speed Wind Tunnel Test - Project C-9
E.G. Kontos

REPORT SUMMARY

This report presents force and moment coefficient plotted data for a low speed wind tunnel test of a nominal 0.113 scale model of the P530 airplane. This test program was conducted during the period from 16 October to 19 October 1968.

The objectives of the test were to obtain:

1. Longitudinal and lateral-directional characteristics at high angles of attack and sideslip.
2. Effect of vertical tail configurations
3. Effect of horizontal tail planforms

TEST CONDITIONS

Mach No.	= 0.2 - 0.22
R.N./Foot	= $1.3 - 1.5 \times 10^6$
A.O.A Range	= -6° to 40°
Sideslip Range	= -10° to 28°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 32.

CONFIGURATION CHANGES

Sketches of LEX configuration changes applicable to this study are shown in Figures 33 and 34. Sketches of vertical tail configuration changes are shown in Figure 36.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 35 shows the effect on $C_{L_{MAX}}$ of the following items, all with flaps 40/20/0:

LEX geometry, W36 and W48

LEX cross-section, W49 and W51

LEX planform, W49 and W50

Figure 37 shows the effect on lateral/directional stability with flaps 40/20/0 of the following:

Vertical tail cant angle, V49 and V54.

Vertical tail planform area, V54 and V55.

Data for the effect of horizontal tails was not sufficient for inclusion.

Dimensions are Model Scale

Wing Area = 5.102 Ft^2

M.A.C. = 17.162 in

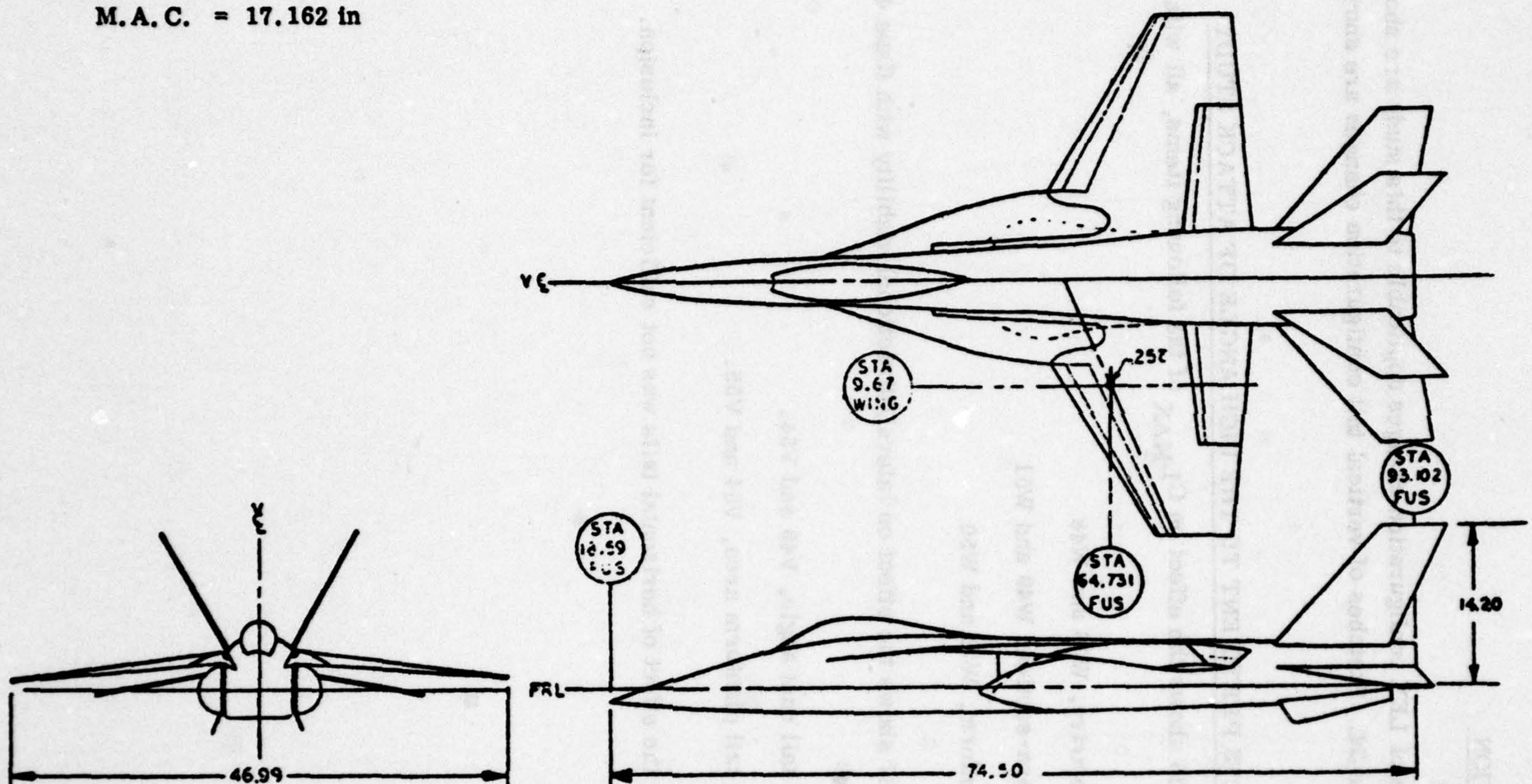
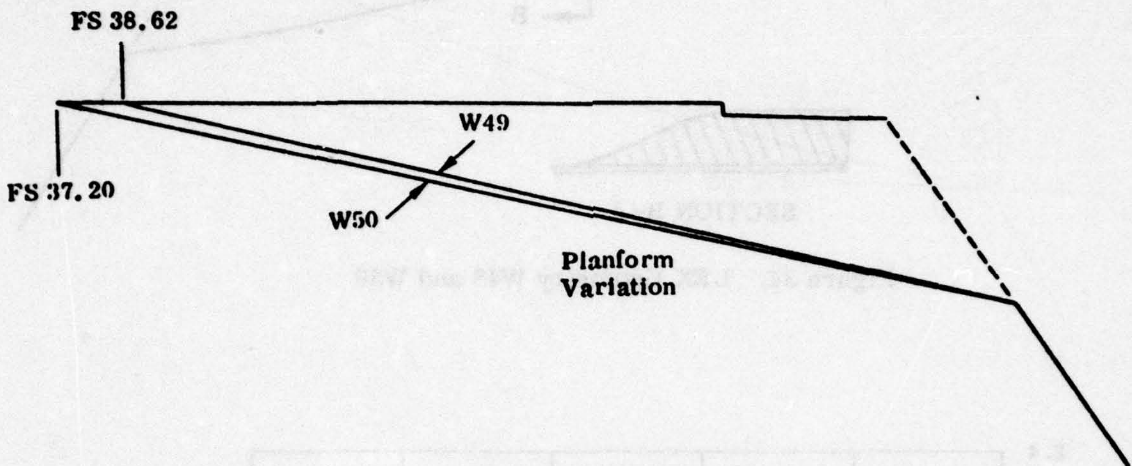


Figure 32. General Three View



Cross Section Variation

WING	Λ^{o} (LEX Sweep)	SECTION B-B (See Ref. 24)
W49	74°	
W51	74°	

Planform Similar to W35 (Refer to Figure 25)

Figure 33. Variation in LEX Cross-Section and Planform Area

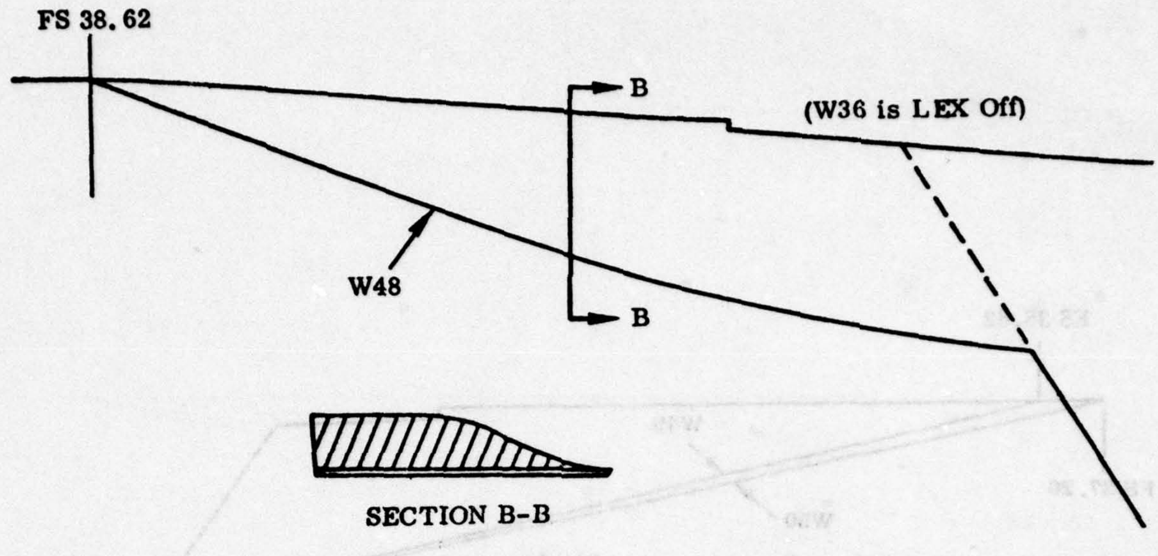


Figure 34. LEX Geometry W48 and W36

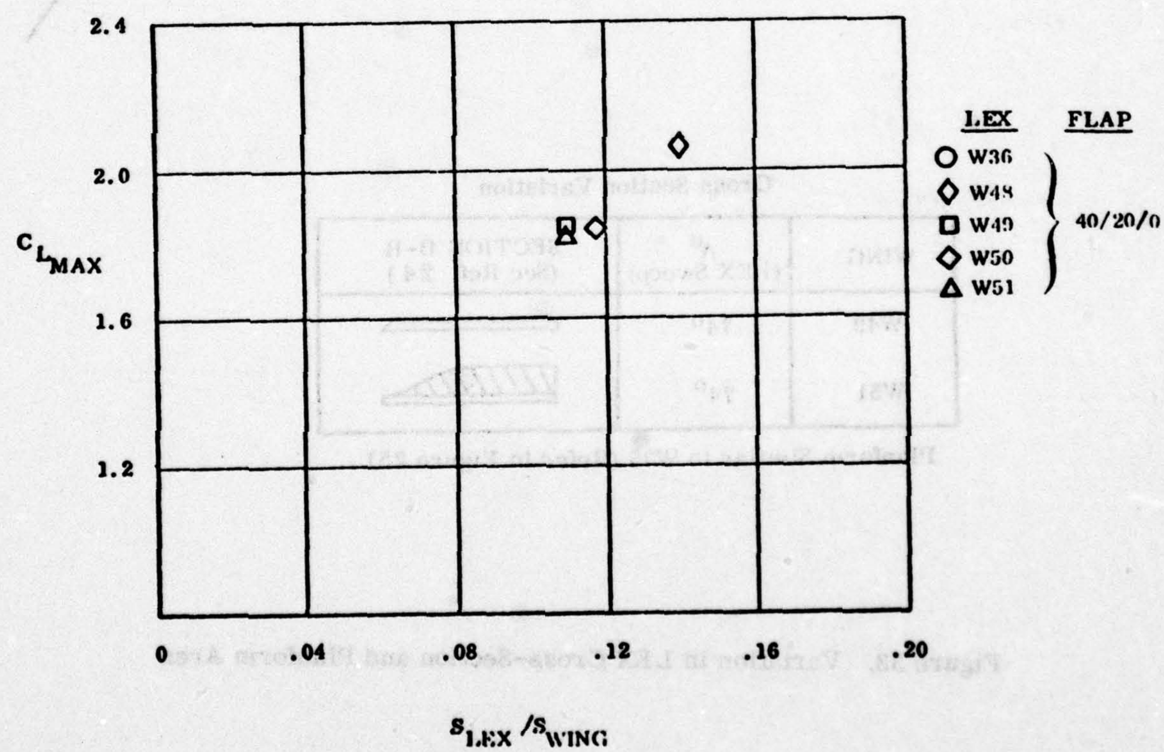
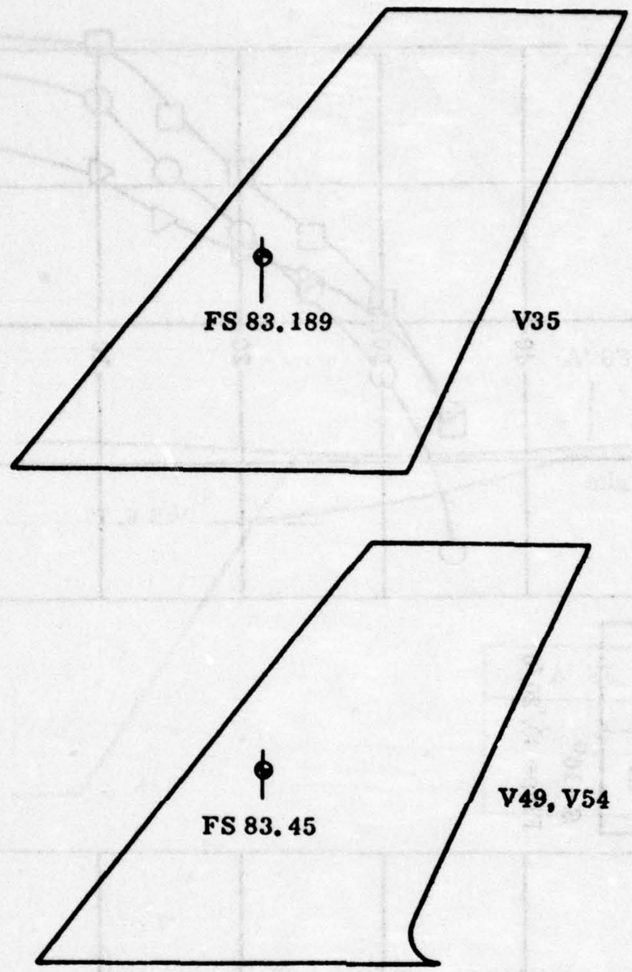


Figure 35. Effect of LEX Geometry on $C_{L_{MAX}}$



VERTICAL	CANT ANGLE	AREA/PANEL SQ. IN.
V49	30°	87.3
V54	40°	87.3
V55	40°	105.7

Figure 36. Vertical Tail Cant Angle and Planform Area Variation

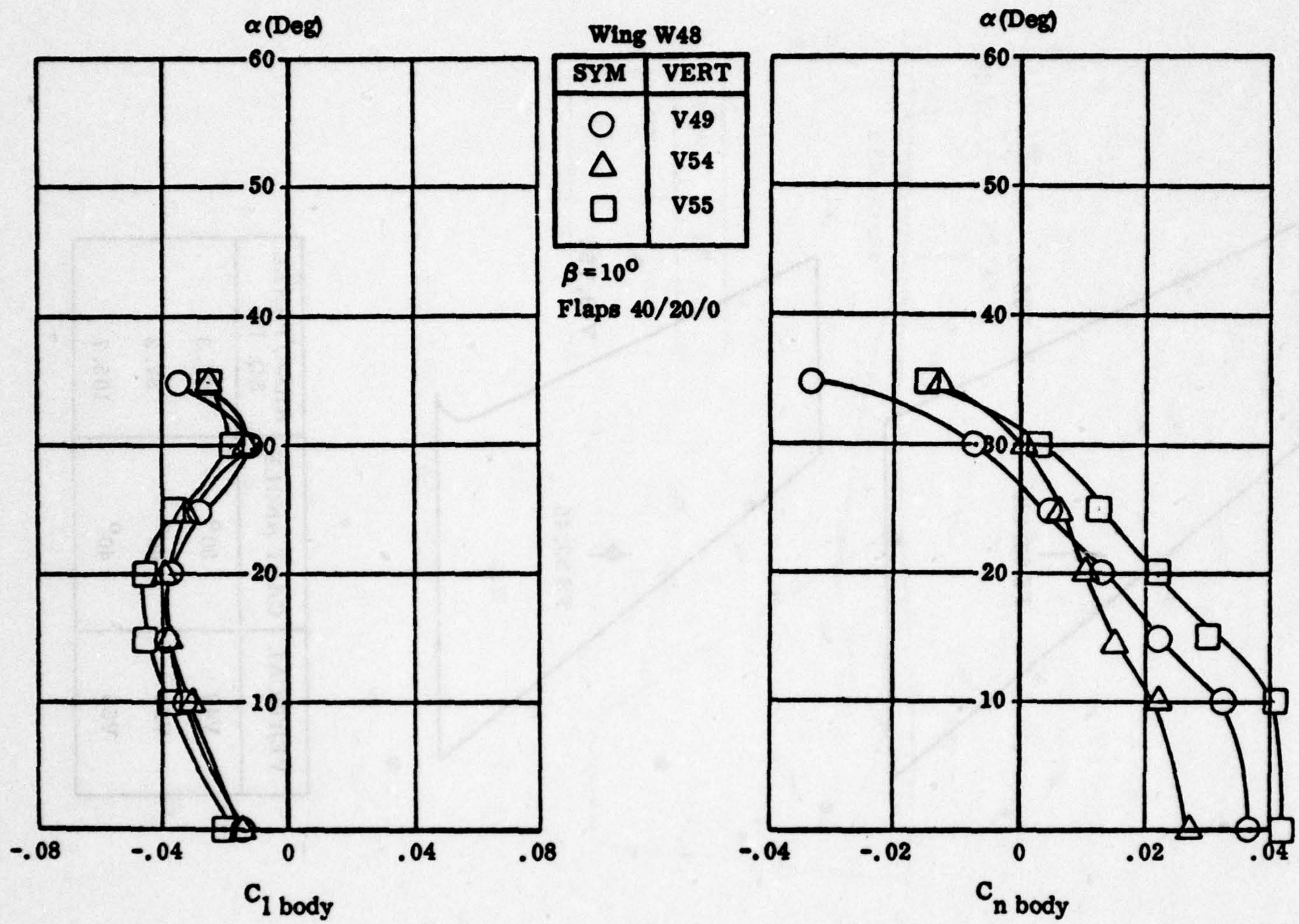


Figure 37. Vertical Tail Effects

AIRCRAFT P530 **REFERENCE** 10

TEST REPORT

NOR 69-132 — Data Report of a Nominal 0.113 Scaled P530 Force Model Low Speed Wind Tunnel Test - Project C-10
E. G. Kontos, W. Rehm — Parts 1 to 4

REPORT SUMMARY

The report presents force and moment coefficient plotted data for a low speed wind tunnel test of a nominal 0.113 scale model of the P530 airplane. This test program was conducted during the period from 4 December 1968 to February 1969.

The objectives of the test were to obtain:

1. Longitudinal and lateral-directional characteristics at high angles of attack and sideslip
2. Effect of wing leading edge extension configuration
3. Effect of vertical tail configuration
4. Horizontal tail effectiveness
5. Effect of speed brakes
6. Effect of pylon-mounted stores
7. Flow visualization

TEST CONDITIONS

Mach No.	= 0.2 - 0.22
R. N./Foot	= $1.4 - 1.5 \times 10^6$
A.O.A. Range	= -6^o to 40^o
Sideslip Range	= -10^o to 28^o

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 38.

CONFIGURATION CHANGES

Sketches of configuration changes applicable to this study are shown in the following figures:

Figure 39, LEX/Wing Fairing
Figure 40, Wing Tip Shape Variation
Figure 41, LEX Planform Variation
Figure 42, LEX Strake Configurations
Figure 43, Strake Width Variation
Figure 44, LEX Cross-Section Variation
Figure 45, Strake Length Variation
Figure 49, Vertical Tail Configurations

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figures 46, 47 and 48 show the effect on $C_{L_{MAX}}$ of the following items, all with flaps 40/20.

LEX planform, W63 through W67 and W72

LEX/wing fairing, W52 and W56

LEX length, W58, W69 and W70

Concave LEX, W76

LEX strakes, W58, W71, W74, W75 and W79

LEX width, W74 and W77

LEX cross-section, W77 and W81

Strake length, W77 and W80

Wing tip shape variation had no effect on $C_{L_{MAX}}$.

Figure 50 shows lateral/directional stability data for select vertical tails V56 through V59, all with wing W77 and flaps 40/20/0.

Data for objectives 4 through 7 listed above was either insufficient or not considered pertinent.

Dimensions are Model Scale

Wing Area = 5.102 Ft^2

M.A.C. = 17.62 in

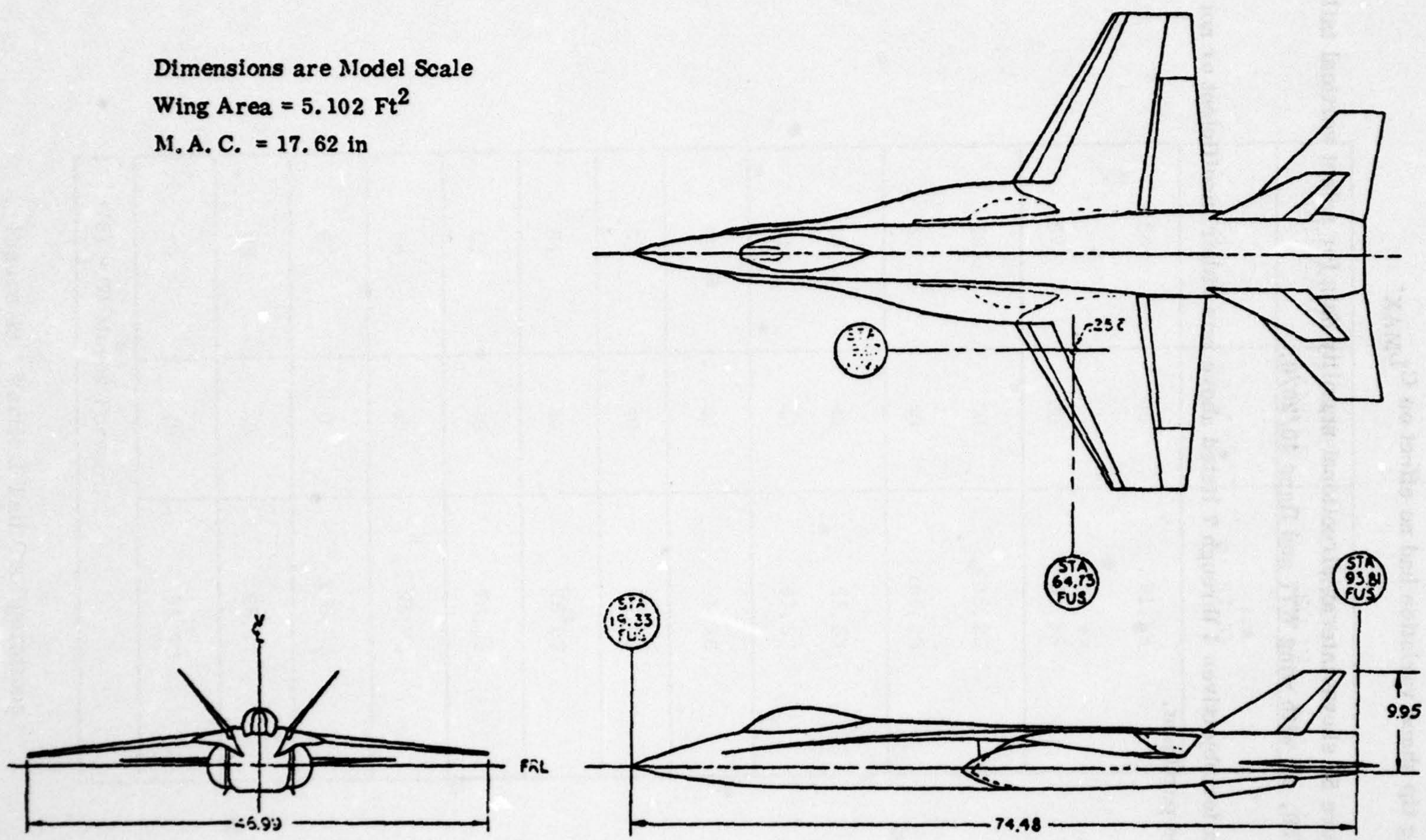


Figure 38. General Three View

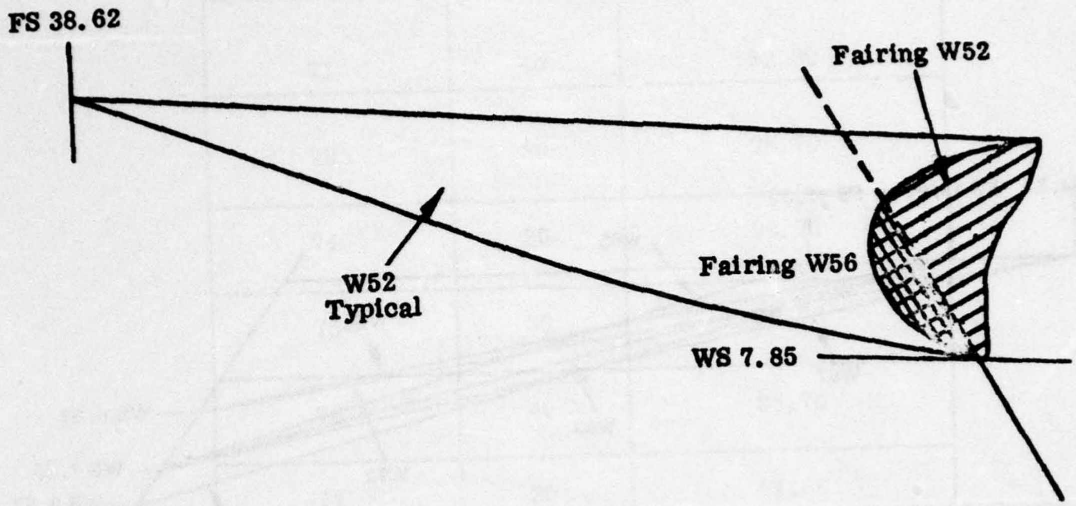


Figure 39. LEX/Wing Fairing

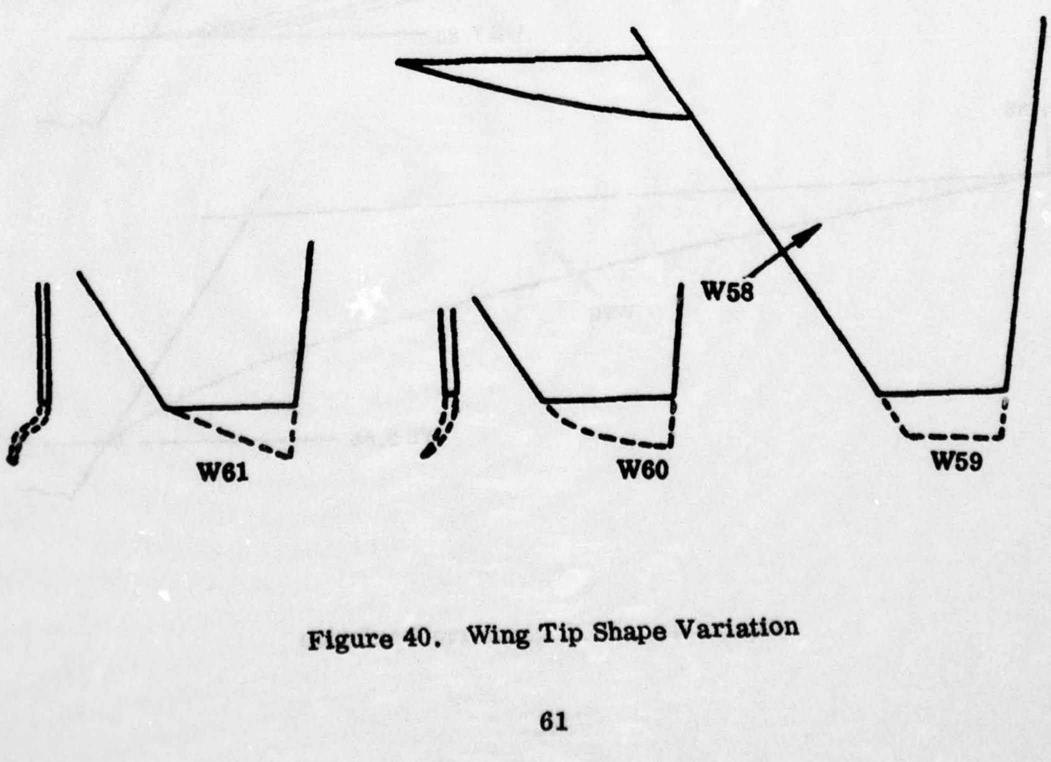


Figure 40. Wing Tip Shape Variation

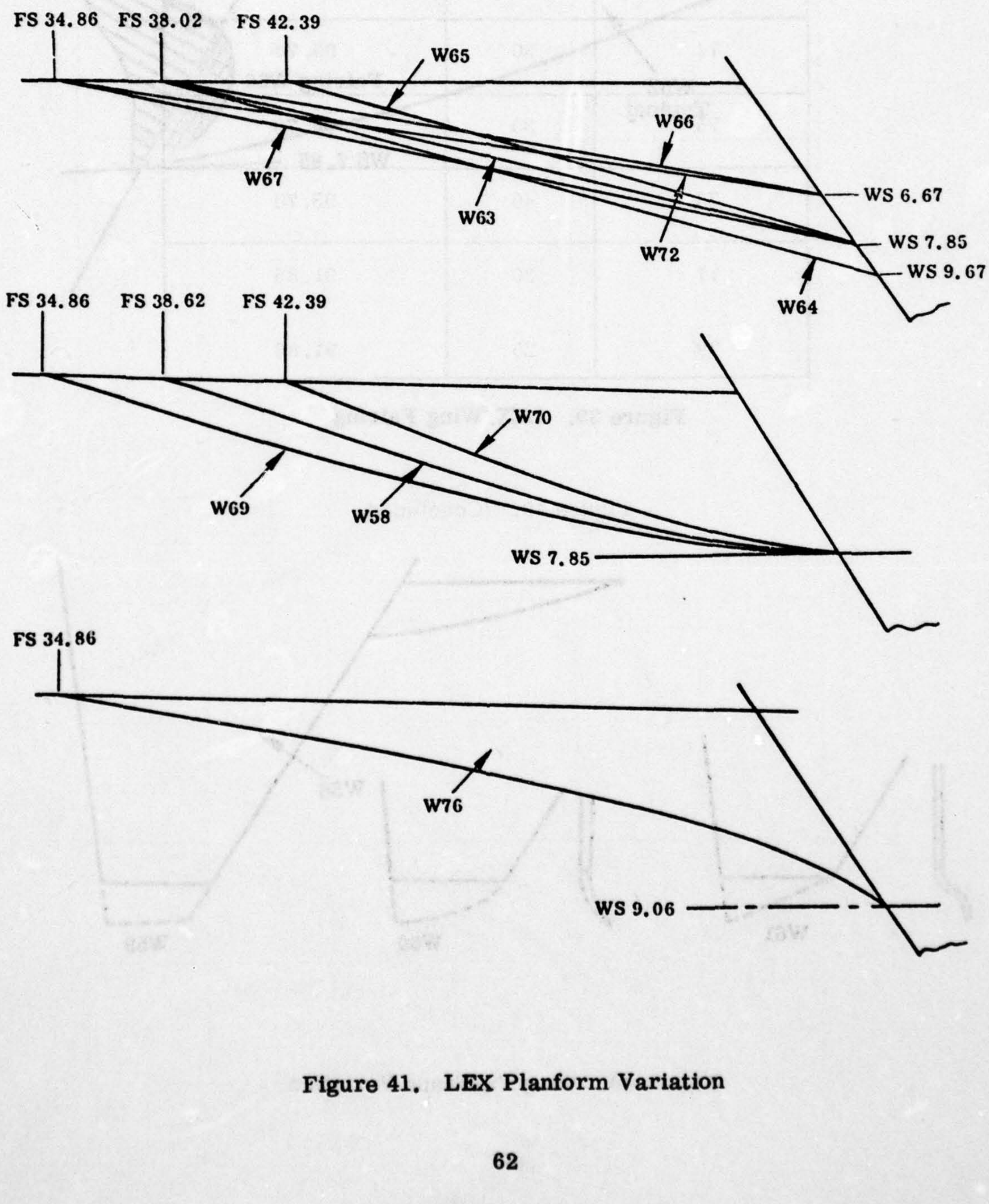
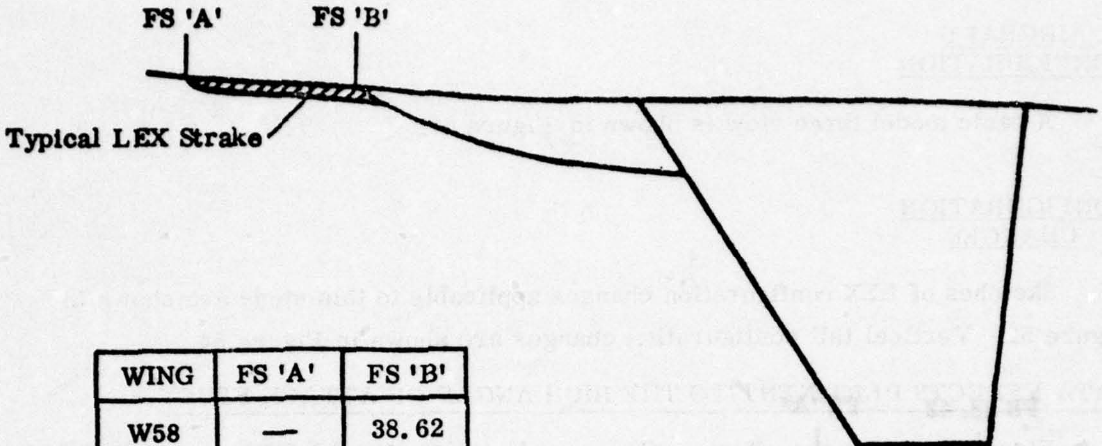


Figure 41. LEX Planform Variation



WING	FS 'A'	FS 'B'
W58	—	38.62
W71	28.42	38.62
W74	—	34.86
W75	28.42	34.86
W79	0	34.86

Figure 42. LEX Strake Configurations

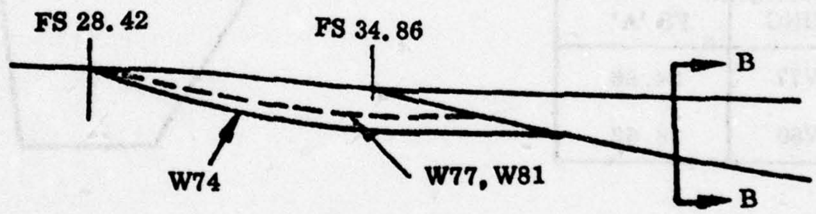
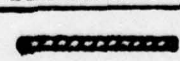
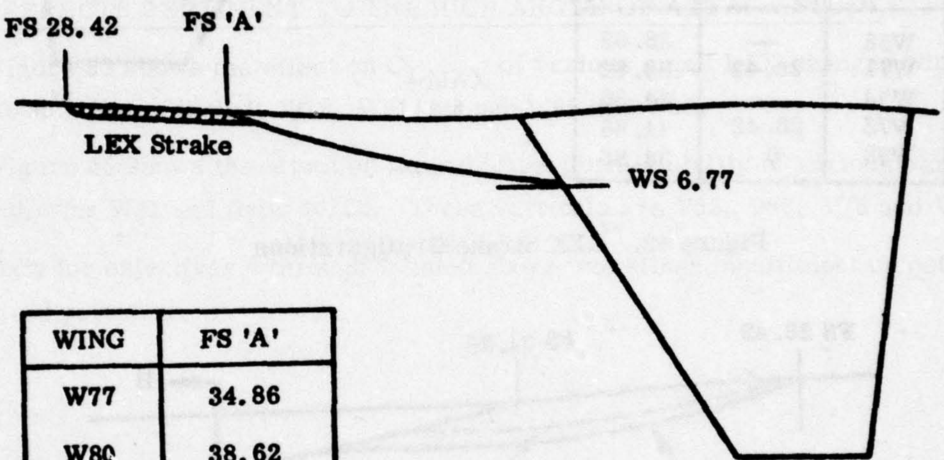


Figure 43. Strake Width Variation

WING	SECTION B-B
W77	
W81	

Planform shown in Figure 43

Figure 44. LEX Cross-Section Variation



WING	FS 'A'
W77	34.86
W80	38.62

Figure 45. Strake Length Variation

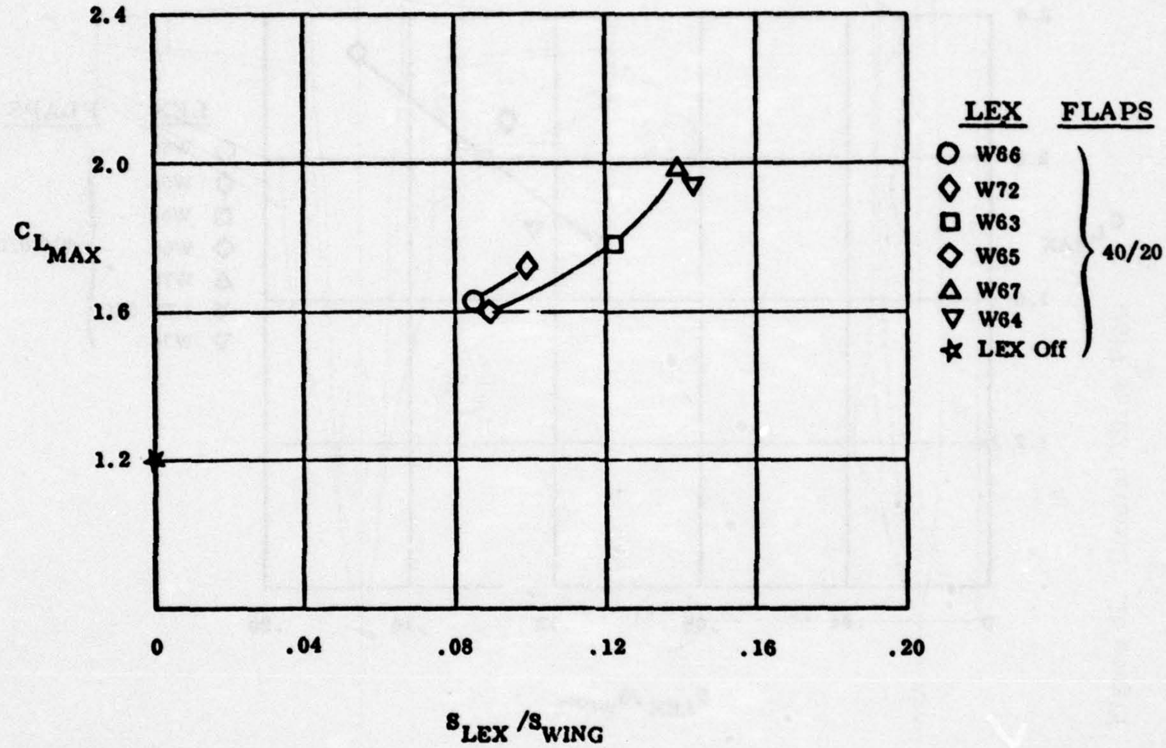


Figure 46. Effect of LEX Planform on $C_{L_{MAX}}$

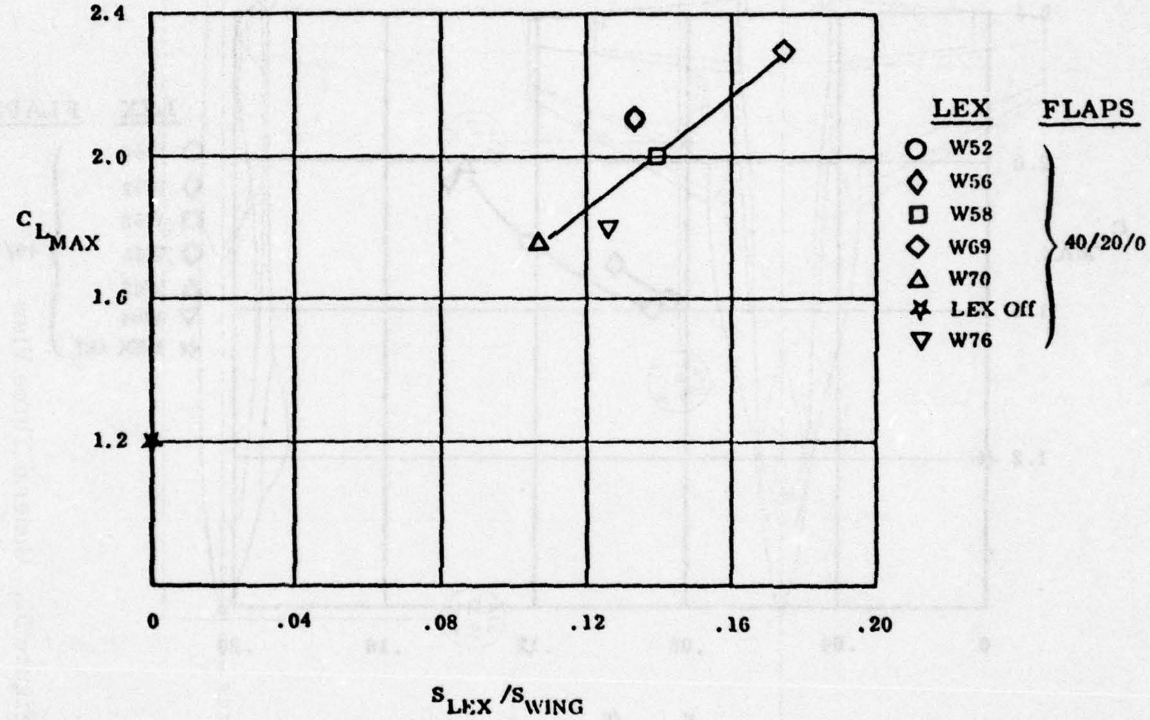


Figure 47. Effect of LEX Geometry on $C_{L_{MAX}}$

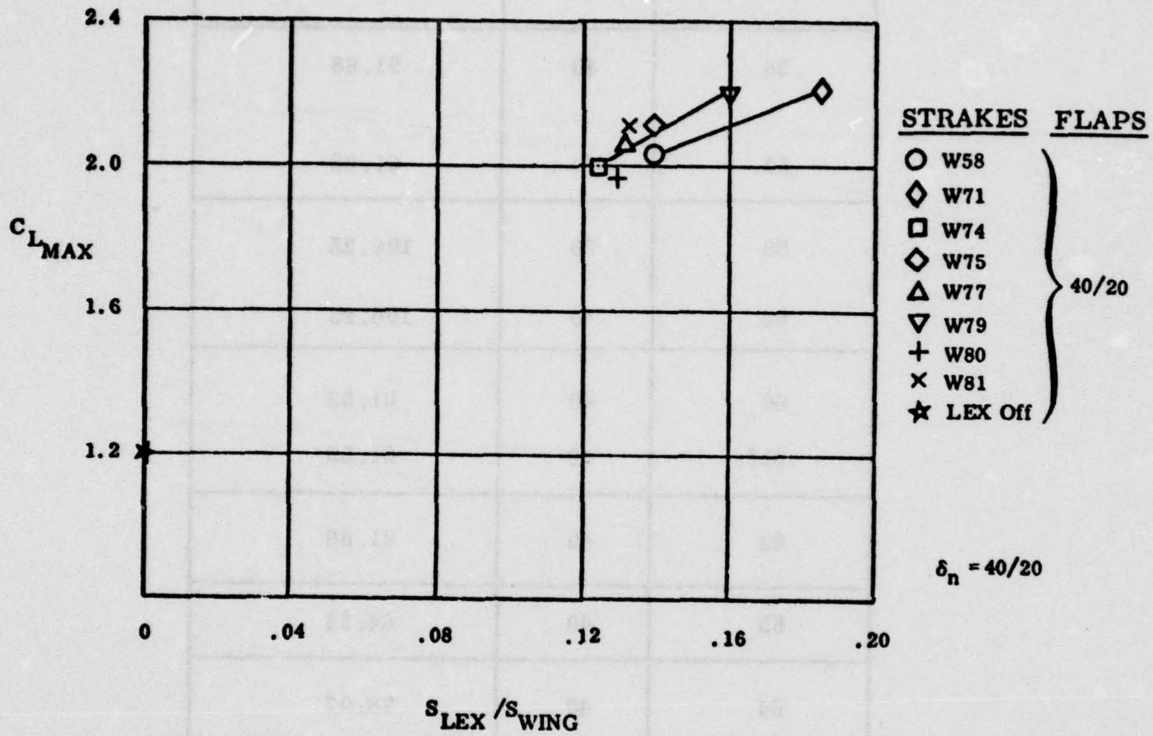


Figure 48. Strake Effects on $C_{L_{MAX}}$

VERTICAL	CANT ANGLE	AREA/PANEL SQ. IN.
54	40	87.31
56	40	91.88
57	30	91.88
58	30	106.25
59	40	106.25
60	40	61.53
61*	40	61.53
62	40	91.86
63	40	64.34
64	40	78.07
65	40	78.31
66	40	95.73
67	0	208.05
69	40	95.70
70	40	95.73
* 61 = 60 Moved Forward		

Figure 49. Vertical Tail Configurations

VERTICAL	CANT ANGLE	AREA/PANEL SQ. IN.
71	40	92.30
73	30	95.70
74	30	95.70
75	30	95.73
76	40	95.70
77	30	91.86
79	20	91.86

Figure 49. (Concluded)

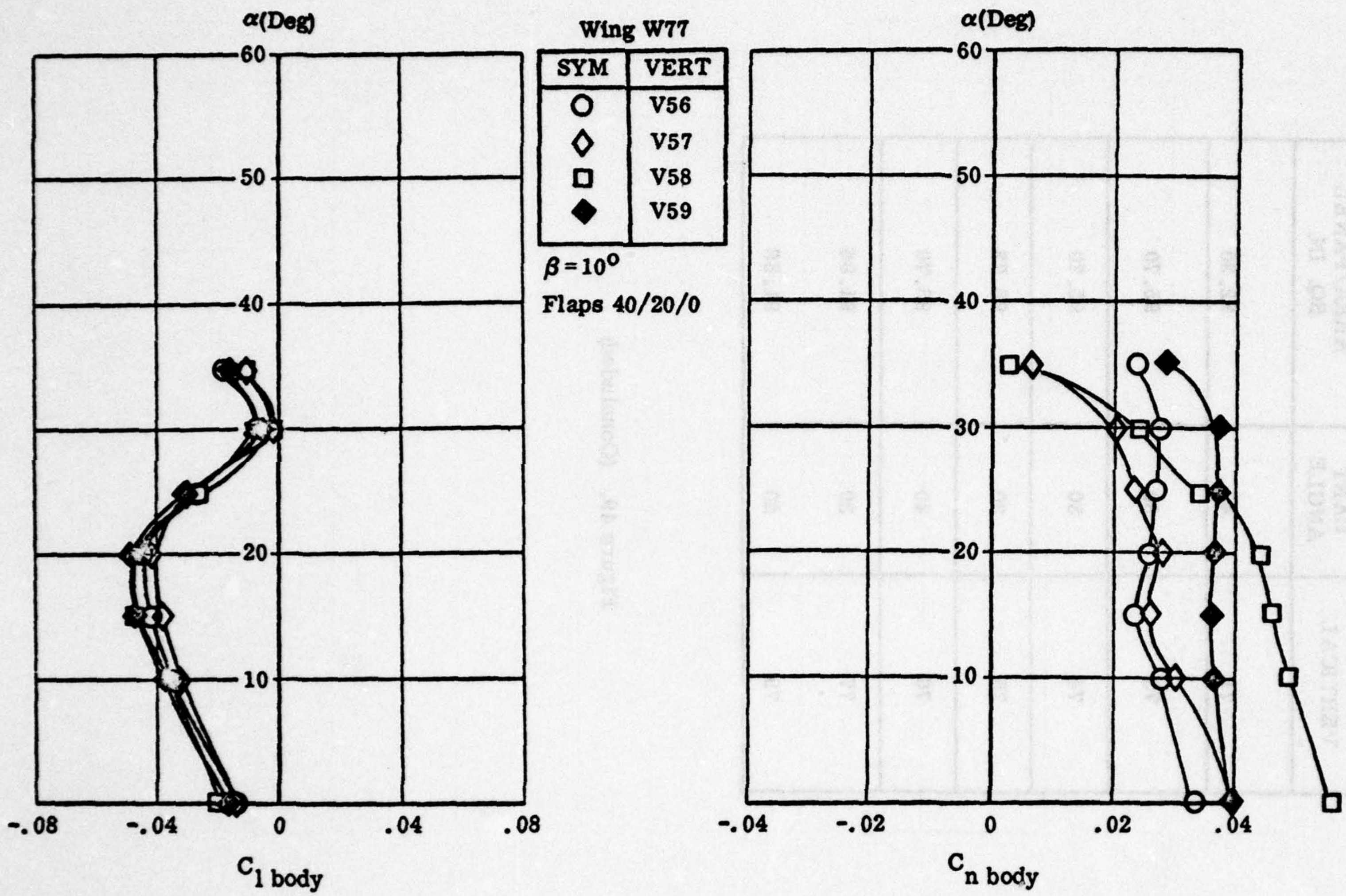


Figure 50. Selected Vertical Tail Data

AIRCRAFT $\boxed{\text{P530}}$ **REFERENCE** $\boxed{11}$

TEST REPORT

NOR 69-133 — Data Report of a Nominal 0.113 Scaled P530 Force Model Low Speed Wind Tunnel Test-Project C-11

E. G. Kontos, W. Rehm — Parts 1 and 2

REPORT SUMMARY

This report presents force and moment coefficient plotted data for a low speed wind tunnel test of a nominal 0.113 scale model of the P530 airplane. This test program was conducted during the period from 27 February to 25 March 1969.

The objectives of the test were to obtain:

1. Longitudinal and lateral-directional characteristics at high angles of attack and sideslip.
2. Effect of wing leading edge extensions
3. Effect of vertical tail configurations
4. Effect of horizontal tail height and dihedral
5. Horizontal tail effectiveness
6. Effect of speed brakes
7. Effect of fuel tanks at W. S. 92

TEST CONDITIONS

Mach No.	= 0.2
R. N./Foot	= 1.4×10^6
A.O.A. Range	= -6° to 40°
Sideslip Range	= -10° to 28°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 51.

CONFIGURATION CHANGES

Sketches of LEX configuration changes applicable to this study are shown in Figure 52. Vertical tail configuration changes are shown in Figure 54.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 53 shows the effect on $C_{L_{MAX}}$ of various small LEX changes with flaps 40/20. These include W72, W81 through W88 and W93.

Figure 55 shows the effect on lateral/directional stability of various vertical taile with wing W81 and flaps 40/20. These verticals are V62, V66, V78 and V85.

Data for objectives 4 through 7 listed above was either insufficient or not considered pertinent.

Dimensions are Model Scale

Wing Area = 5.102 Ft^2

M.A.C. = 17.162 in

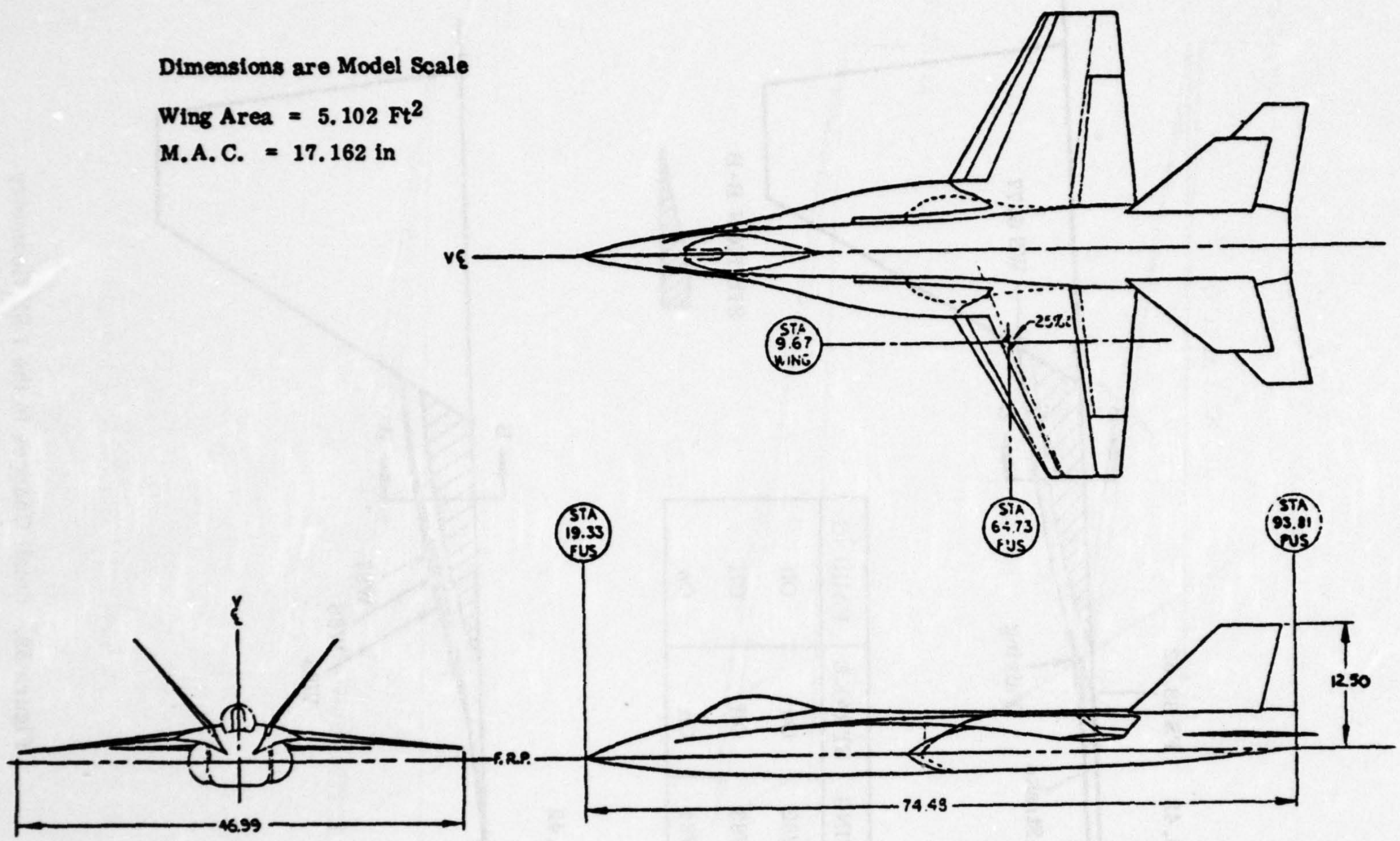
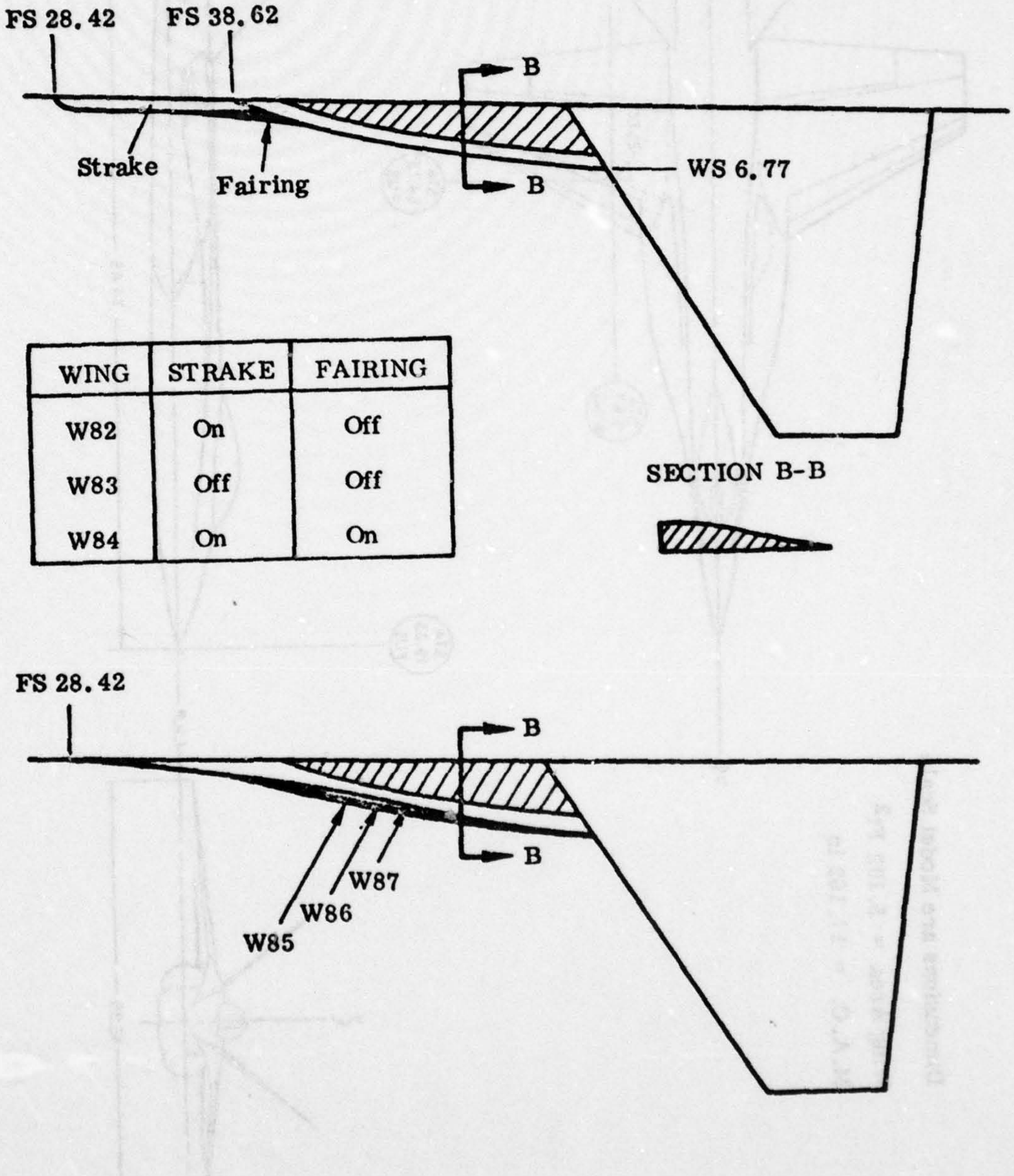


Figure 51. General Three View



WING	STRAKE	FAIRING
W82	On	Off
W83	Off	Off
W84	On	On

Figure 52. Small Changes in the LEX Geometry

AD-A069 647 NORTHROP CORP HAWTHORNE CA AIRCRAFT GROUP F/G 20/4
ANALYSIS OF WIND TUNNEL DATA PERTAINING TO HIGH ANGLE OF ATTACK--ETC(U)
JUL 78 J W HEADLEY F33615-77-C-3062
UNCLASSIFIED NOR-78-69-VOL-2 AFFDL-TR-78-94-VOL-2 NL

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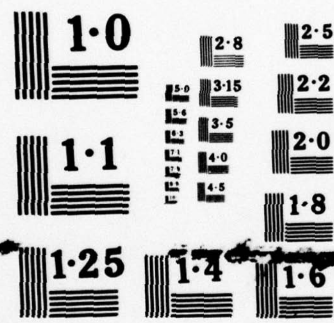


NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

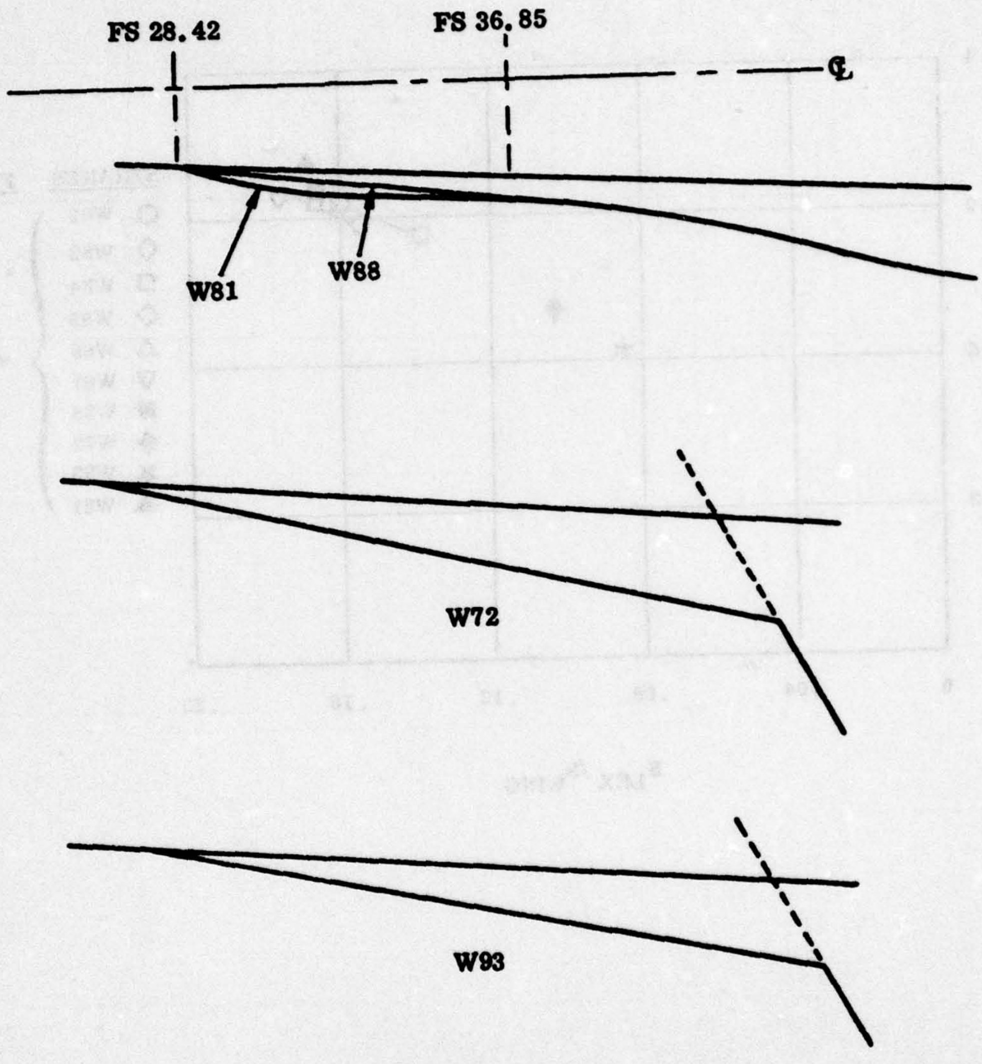


Figure 52. (Concluded)

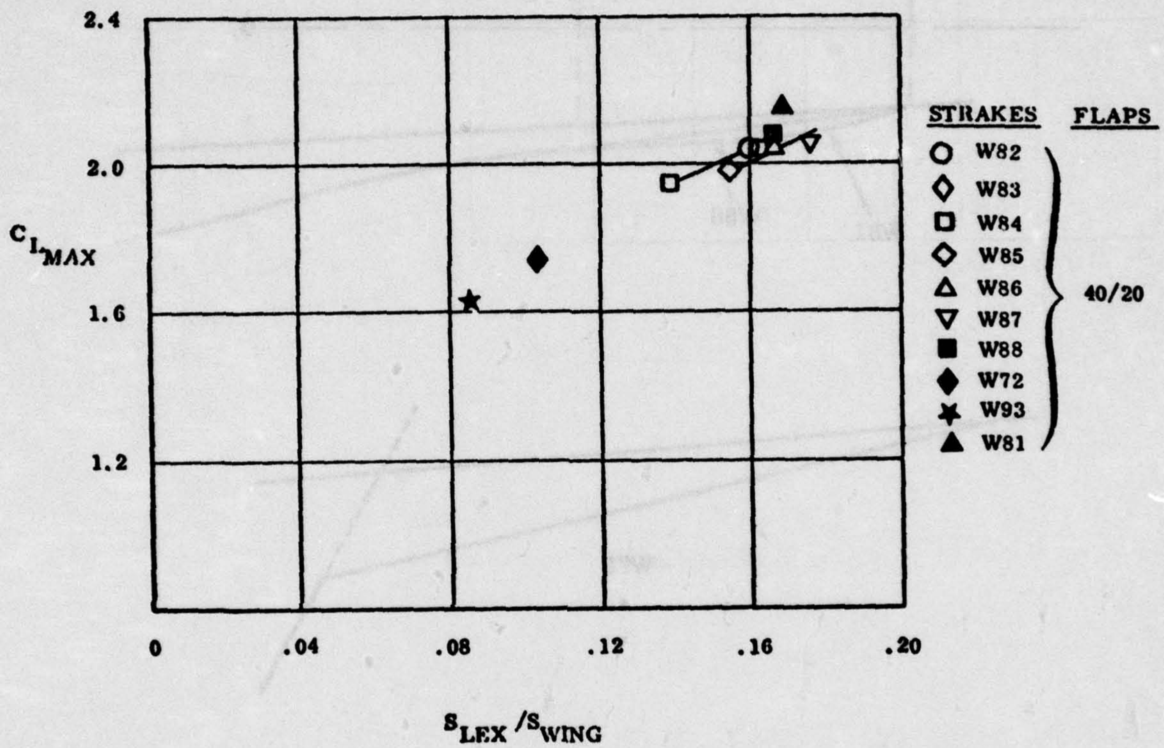


Figure 53. Effect of Small LEX Changes on $C_{L_{MAX}}$

VERTICAL	CANT ANGLE	AREA/PANEL SQ. IN.
62	40	91.86
66	40	95.73
78	30	91.86
85	40	110.19

Twin Verticals Mounted on Aft Fuselage

Figure 54. Variation in Vertical Tail Shape and Cant Angle

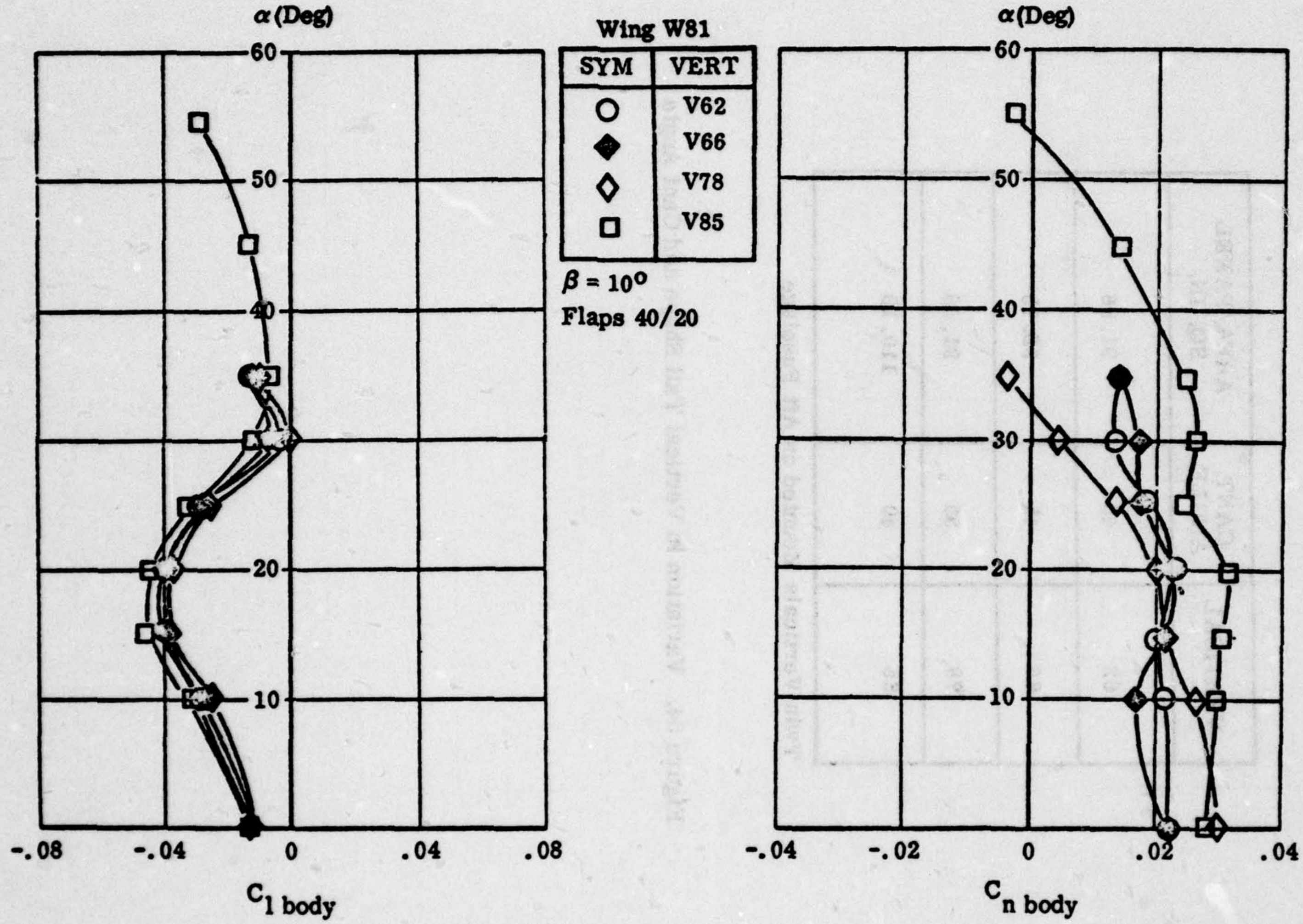


Figure 55. Effect of Various Vertical Tails

AIRCRAFT **P530** REFERENCE **12**

TEST REPORT

NOR 69-144 — **Data Report of a Nominal 0.113 Scaled P530 Force Model Low Speed Wind Tunnel Test-Project C-12**

REPORT SUMMARY

This report presents force and moment coefficient data for a low speed wind tunnel test of a nominal 0.113 scale model of the P530 airplane. This test program was conducted during the period from 9 May 1969 to 13 June 1969.

The objectives of the test were to obtain:

1. **The longitudinal and lateral-directional characterisitics at high angles of attack and sideslip.**
2. **Effect of vertical tail location**
3. **Effect of horizontal tail location**
4. **Effect of wing configuration**
5. **Effect of strakes**
6. **Pressure profile behind speed brake**

TEST CONDITIONS

Mach. No.	**= 0.15 to 0.22**
R.N./Foot	**= 1.0 to 1.5 x 10^6**
A.O.A. Range	**= 10^o to 40^o**
Sideslip Range	**= -12^o to 28^o**

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 51 in Reference 11.

CONFIGURATION CHANGES

Sketches of LEX, Strake and Vertical Tail configuration changes applicable to this study are shown in Figures 56, 59 and 62.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 57 shows the effect on $C_{L_{MAX}}$ of various LEX planforms with flaps 40/20/0. These LEX planforms are W36, W72, W75, W88, W95–W98, W101, W103 and W104.

Figure 58 shows the effect on lateral/directional stability of LEX planforms W95 - W98 and W101. These configurations included vertical tail V85 and flaps 40/20/0.

Figure 60 shows the effect on lateral/directional stability of strake configurations S1, S2 and S3, which include wing W75 and flaps 40/20/0. Figure 2-38 shows similar data for the effect of strake S4, on or off.

Vertical tail (V85 - V87) lateral/directional stability data is shown in Figure 63. These configurations included wing W88 and flaps 40/20/0.

Data for objectives 3 and 6 listed above were either insufficient or not considered pertinent.

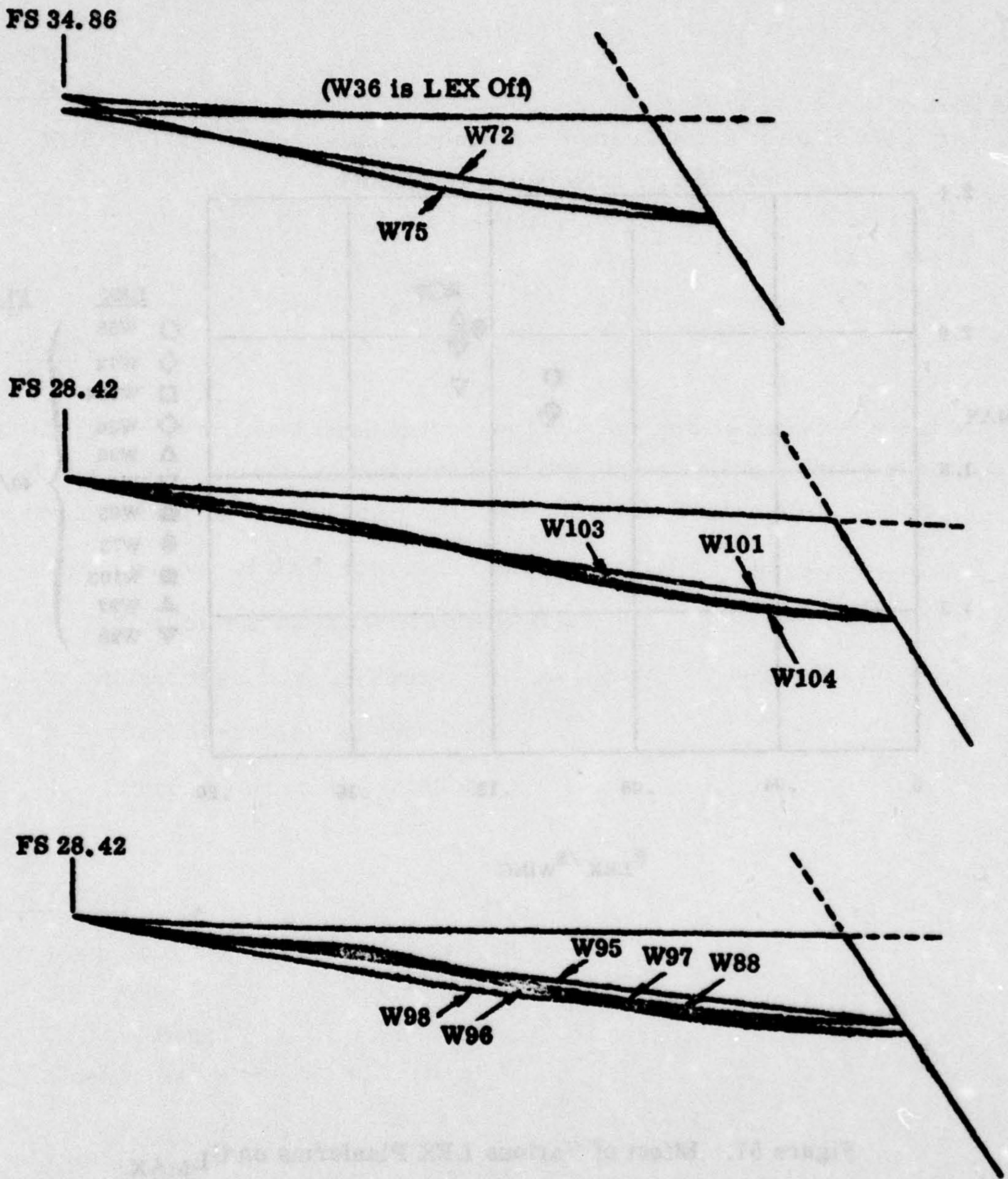


Figure 56. LEX Planform Shapes

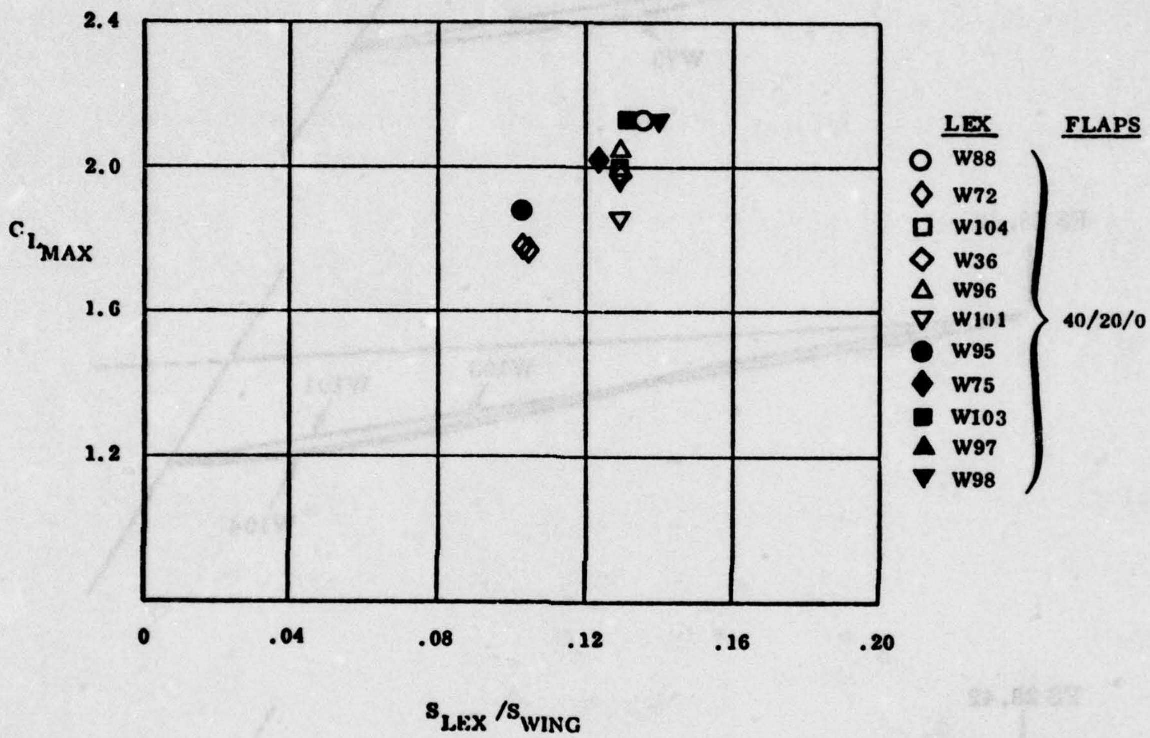


Figure 57. Effect of Various LEX Planforms on $C_{L_{MAX}}$

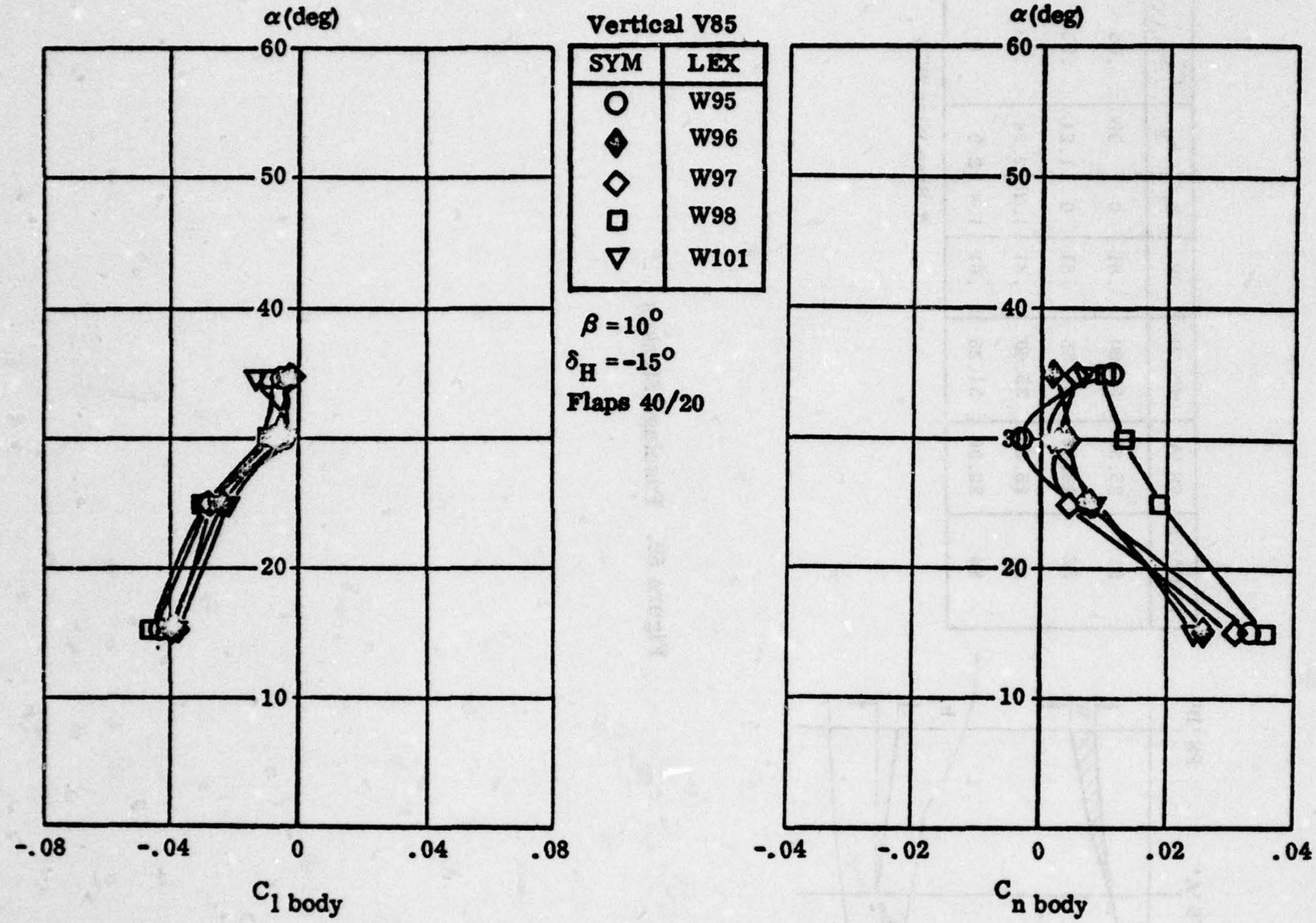
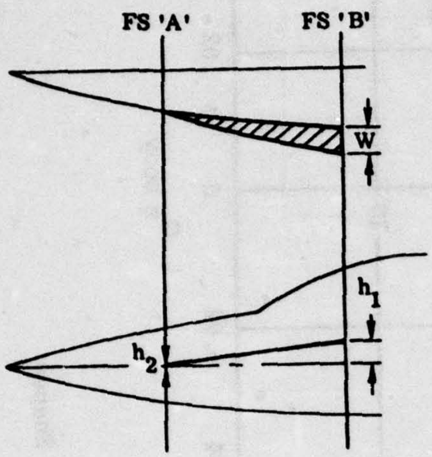


Figure 58. Effect of LEX Shapes



STRAKE	FS 'A'	FS 'B'	W	h_1	h_2	$\Delta C^*_{L,MAX}$
S1	25.36	35.60	.81	0	.99	.05
S2	28.42	38.65	.81	0	1.21	.05
S3	25.36	35.60	.81	1.25	2.24	.05
S4	25.36	31.25	.61	1.4	2.0	0

* Base Wing W75

Figure 59. Fuselage Strakes

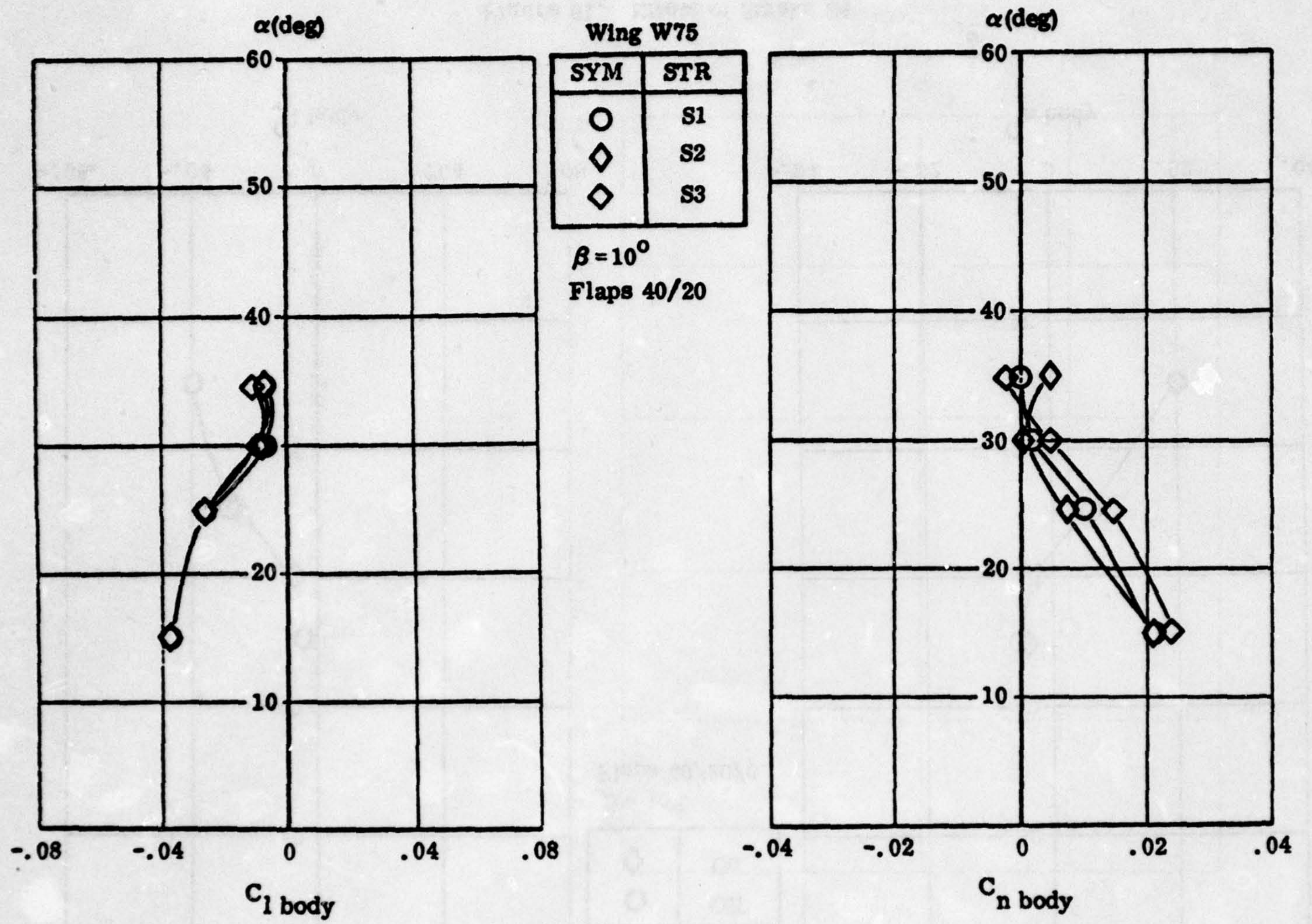


Figure 60. Comparison of Strakes

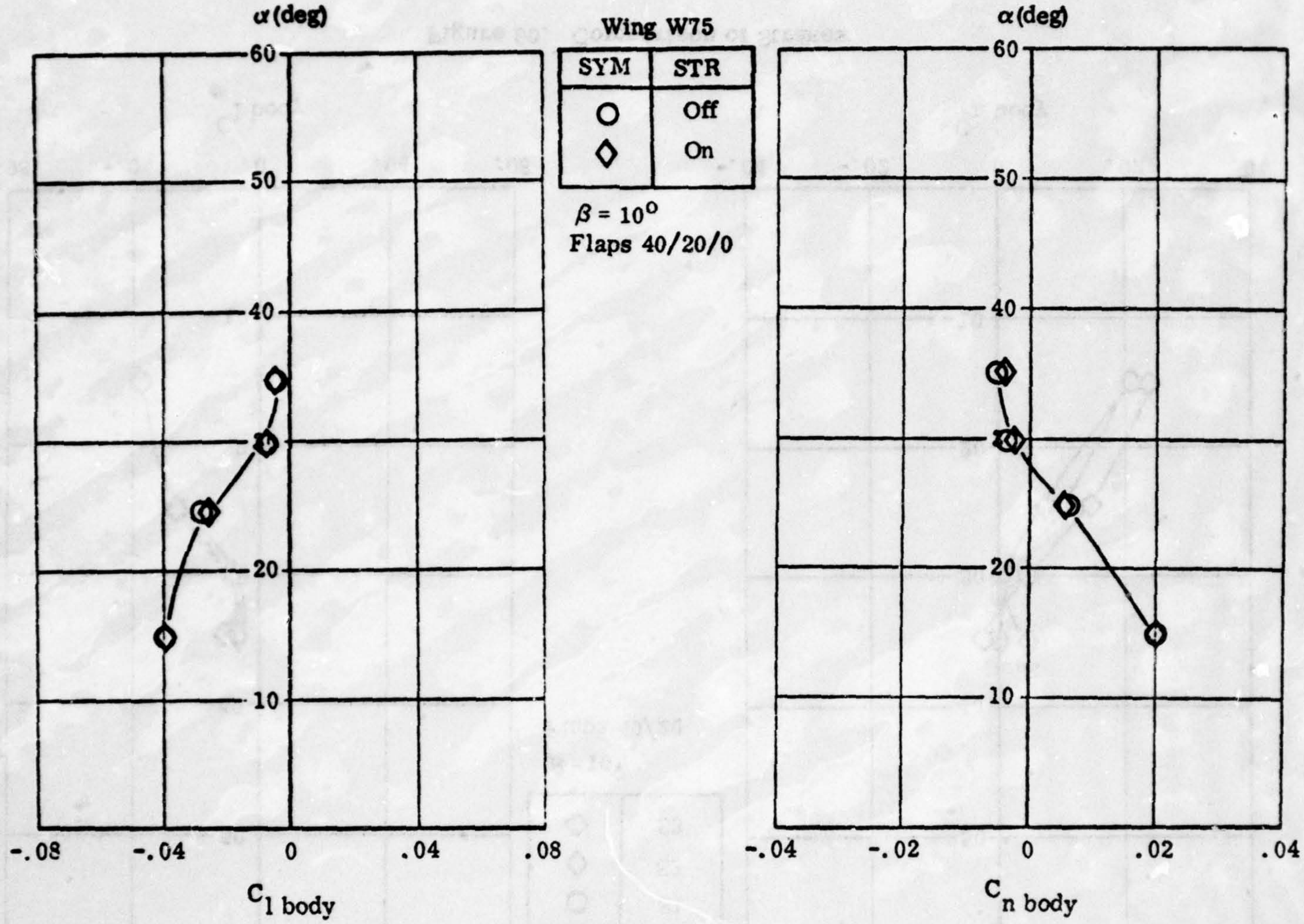
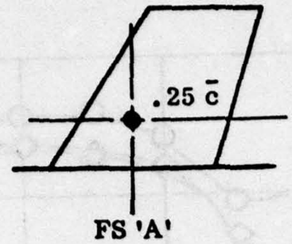


Figure 61. Effect of Strake S4

Cant Angle = 40°

Area = 110.20 in



VERTICAL	FS 'A'
V85	85.19
V86	82.96
V87	84.19

Figure 62. Vertical Tail Configurations

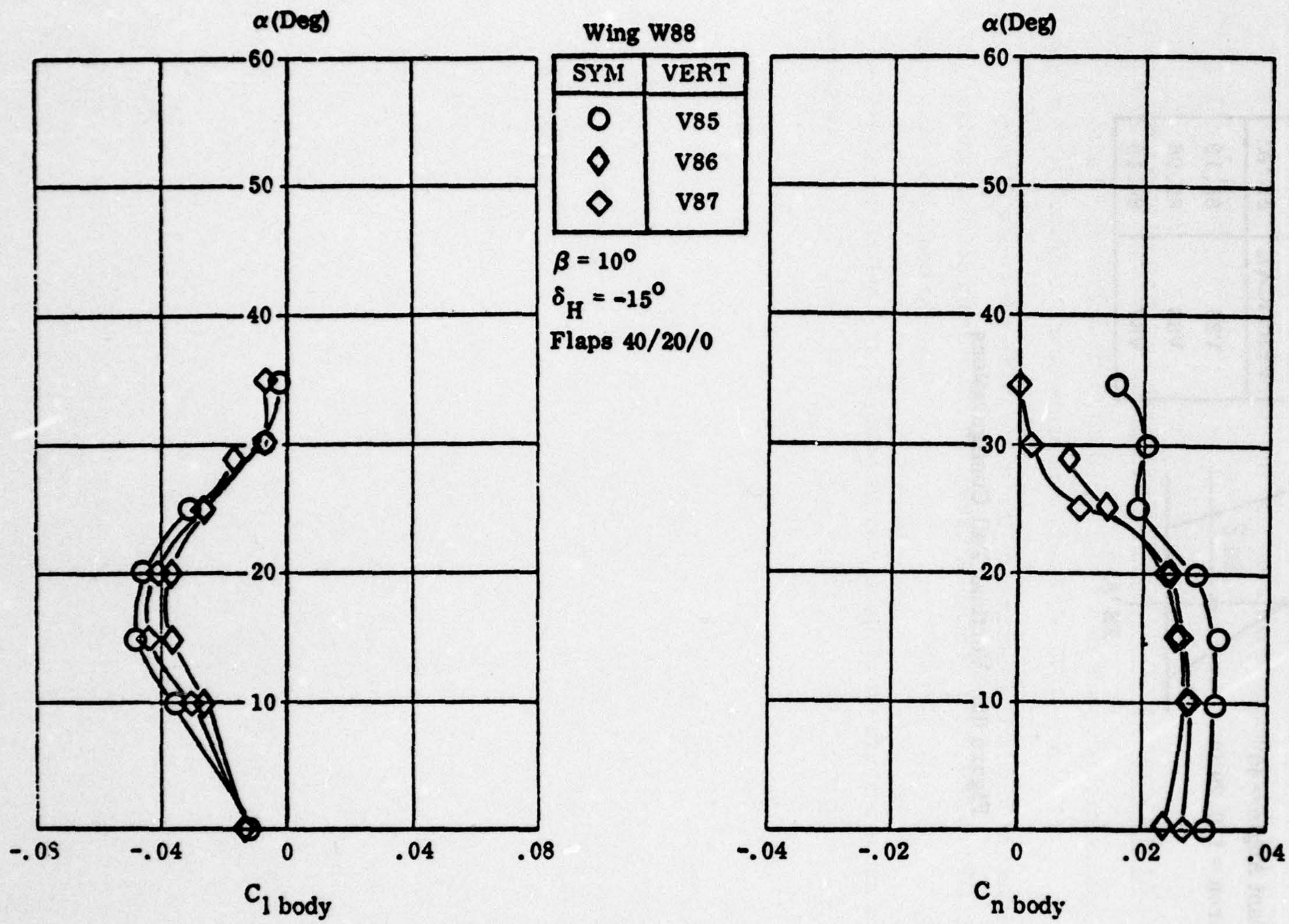


Figure 63. Effect of Vertical Tail Location

AIRCRAFT $\boxed{\text{P530}}$ **REFERENCE** $\boxed{12}$

TEST REPORT

NOR 70-171 **Data Report of a Nominal 0.113 Scale P-530 Force Model Low Speed Wind Tunnel Test**

B.J. de la Puerta **Part I & II**

NAL-A-916

REPORT SUMMARY

This report presents force and moment coefficient data for a low speed wind tunnel test of a nominal 0.113 scale model of the P530 airplane. This test program was conducted during the period from 18 August to 1 September 1970.

The objectives of the test were to obtain:

1. **Effect of leading and trailing edge flaps**
2. **Effect of vertical tail area**
3. **Effect of vertical tail cant angle**
4. **Effect of vertical tail location**

TEST CONDITIONS

Mach No.	**= 0.2 to 0.22**
R.N./Foot	**= 1.4 to 1.5 x 10^6**
A.O.A. Range	**= -10° to 28°**
Sideslip Range	**= Various**

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 64.

CONFIGURATION CHANGES

Sketches of vertical tail configuration changes applicable to this study are shown in Figure 65.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 66 shows the effect on $C_{L_{MAX}}$ of vertical tail V86, with wing W88 and flaps up.

Figure 67 shows the effect on lateral/directional stability of various vertical tail cant angles, V86, V89 and V93.

Data for objective 1, the effect of leading and trailing edge flaps was insufficient for inclusion in this study.

Dimensions are Model Scale

Wing Area = 5.102 Ft^2

M.A.C. = 17.162 in^2

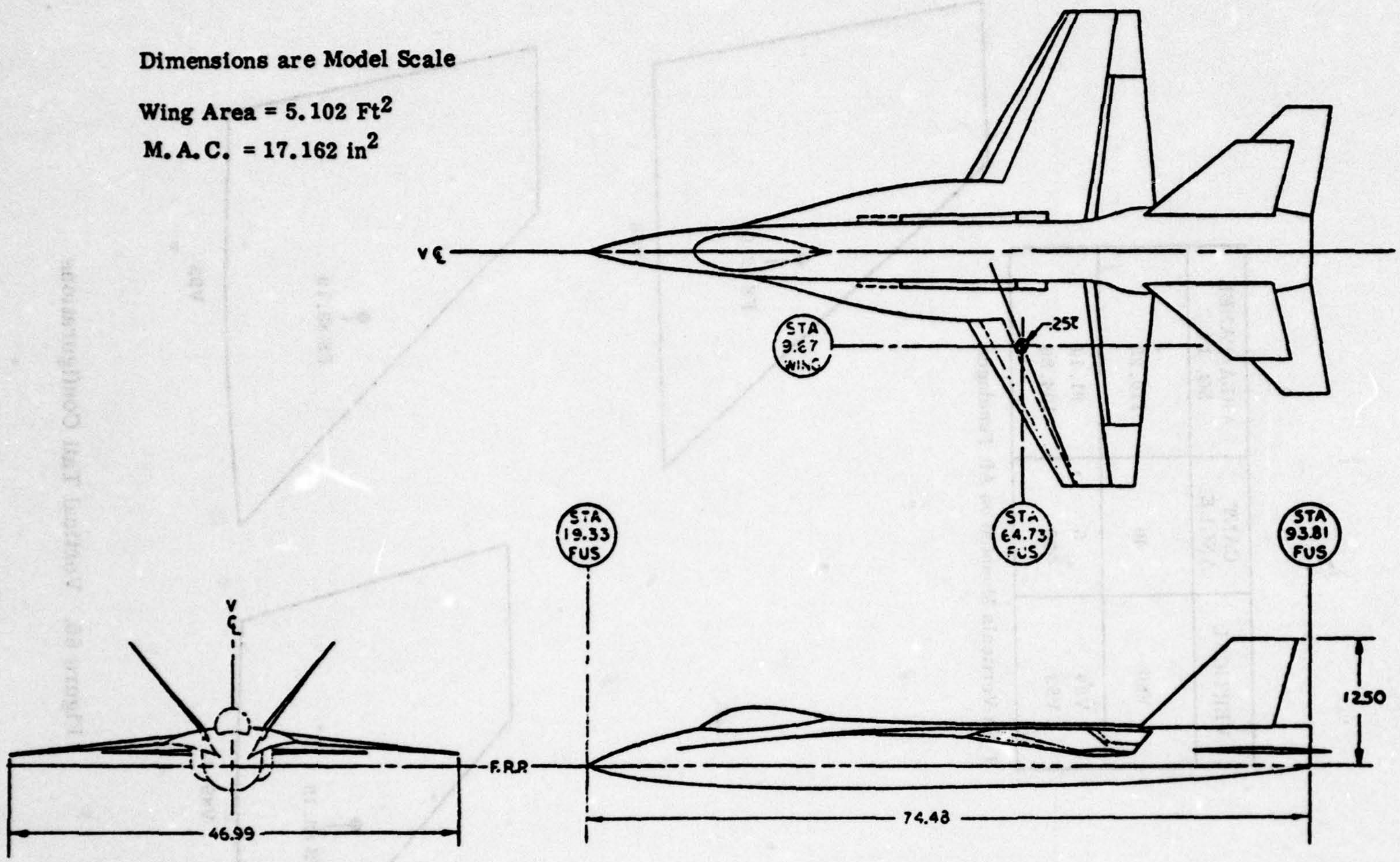


Figure 64. General Three View

VERTICAL	CANT ANGLE	AREA/PANEL SQ. IN.
V86	40	110.23
V89	5	91.14
V93	30	104.86

Twin Verticals Mounted on Aft Fuselages

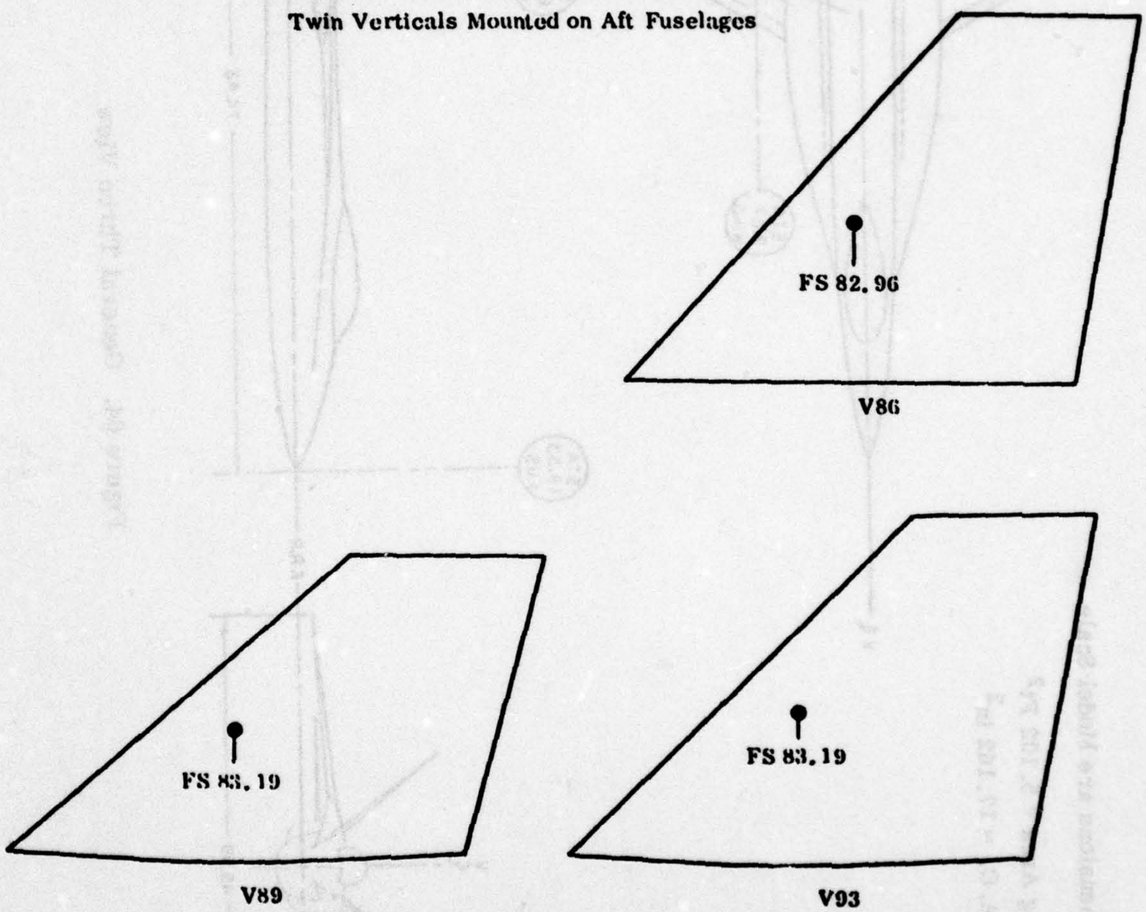


Figure 65. Vertical Tail Configurations

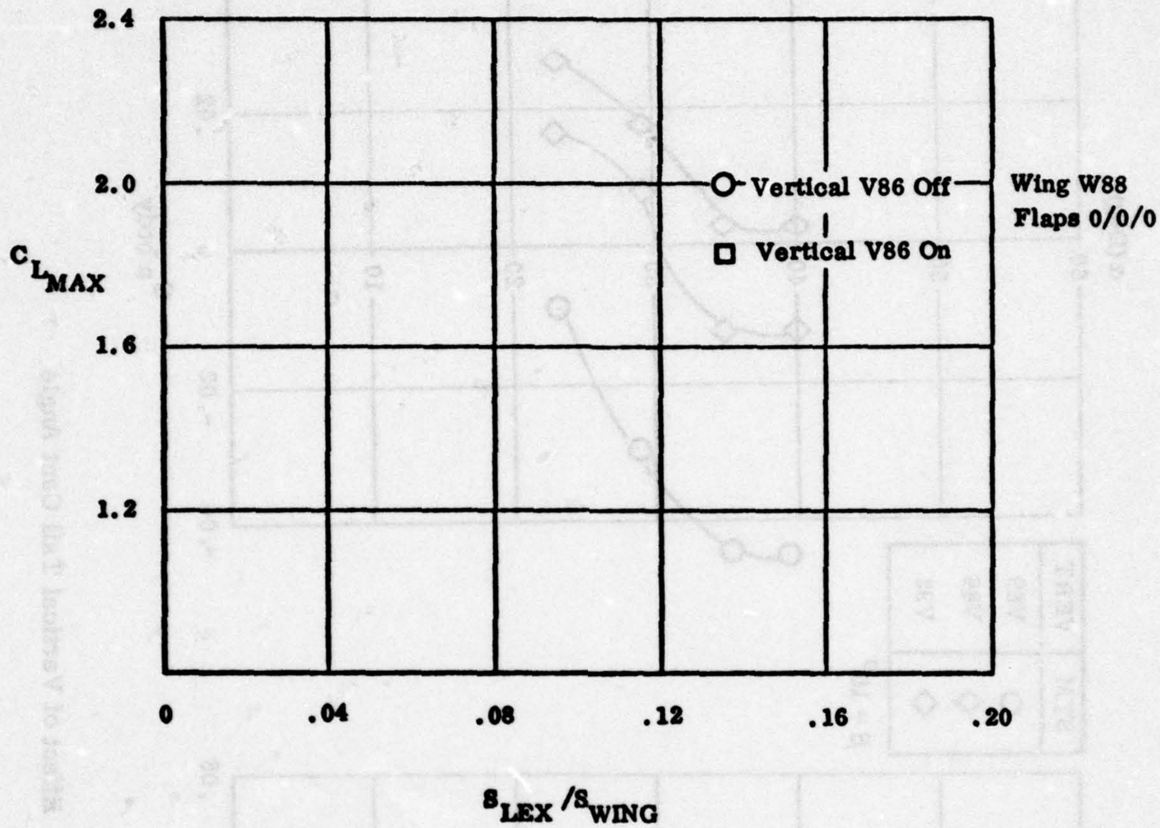


Figure 66. Effect of Vertical (V86) on $C_{L_{MAX}}$

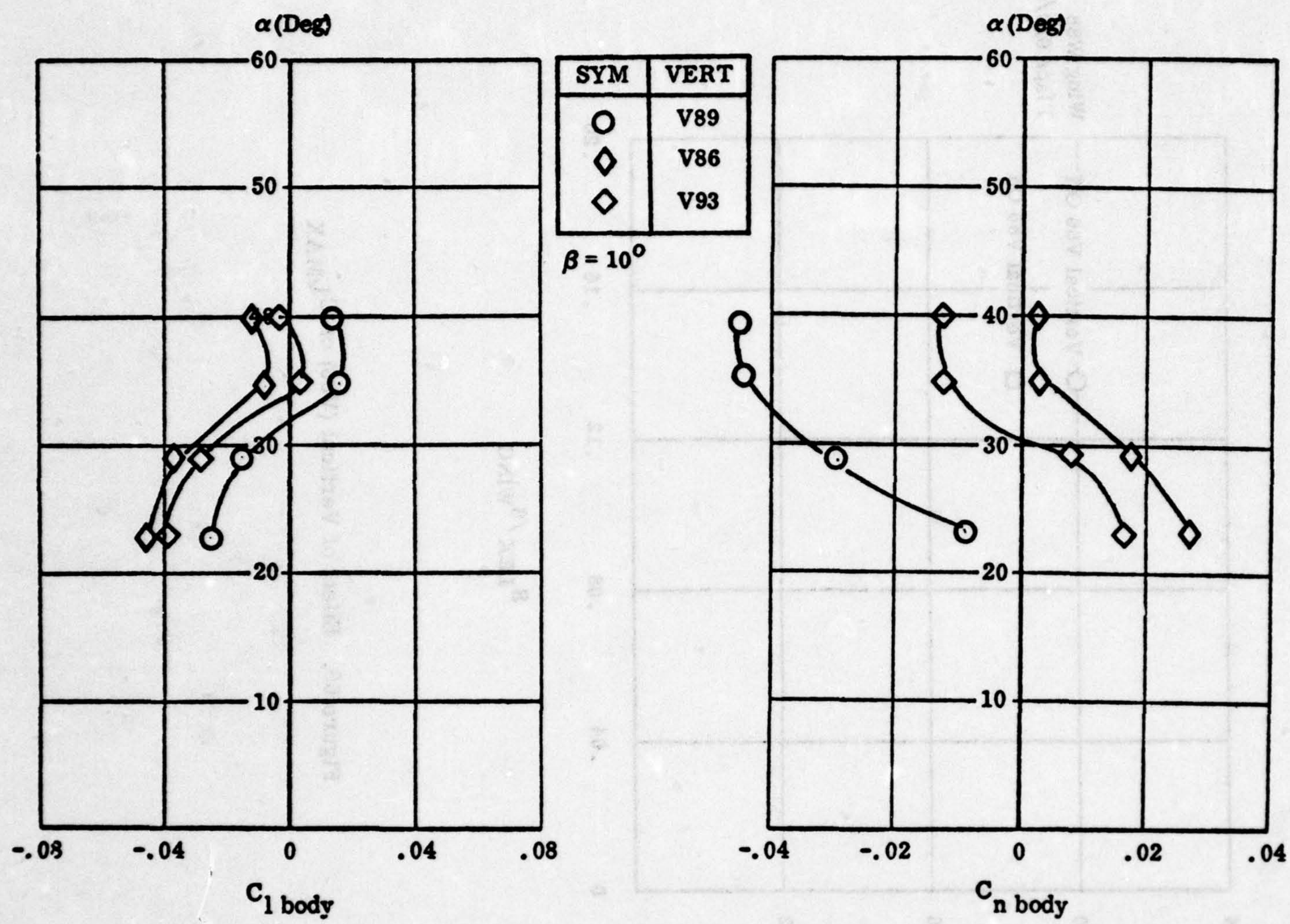


Figure 67. Effect of Vertical Tail Cant Angle

AIRCRAFT **P530** REFERENCE **14**

TEST REPORT

NOR 71-010	Data Report of a Nominal 0.113 Scale P530 Force Model Low Speed Wind Tunnel Tests
	B.J. de la Puerta NAL-A-923

REPORT SUMMARY

This report presents force and moment coefficient data for a low speed wind tunnel test of a nominal 0.113 scale model of the P530 airplane. This program was conducted during the period from 12 to 20 October 1970.

The objective of the test was to obtain:

1. Effect of leading and trailing edge flaps on wing without leading edge extension
2. Effect of leading edge extension configuration
3. Effect of ailerons
4. Effect of ventral fin (no base run)

TEST CONDITIONS

Mach No.	=	0.22
R.N./Foot	=	1.5×10^6
A.O.A. Range	=	-7° to 45°
Sideslip Range	=	-10° to 28°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 64 in Reference 13.

CONFIGURATION CHANGES

Sketches of wing and vertical tail configuration changes applicable to this study are shown in Figures 68 and 70.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 69 shows the effect on $C_{L_{MAX}}$ of small wing planform changes with flaps up or at 40/20/0. These wings are W36, W88, W110 and W111.

Figure 71 shows the effect on lateral/directional stability of the following wing/vertical tail combinations: W36/V99, W36/OFF, W110/V86 and W110/OFF. Flaps were positioned at 40/20/0.

Data for objective 3 and 4 listed above was either insufficient or not considered pertinent.

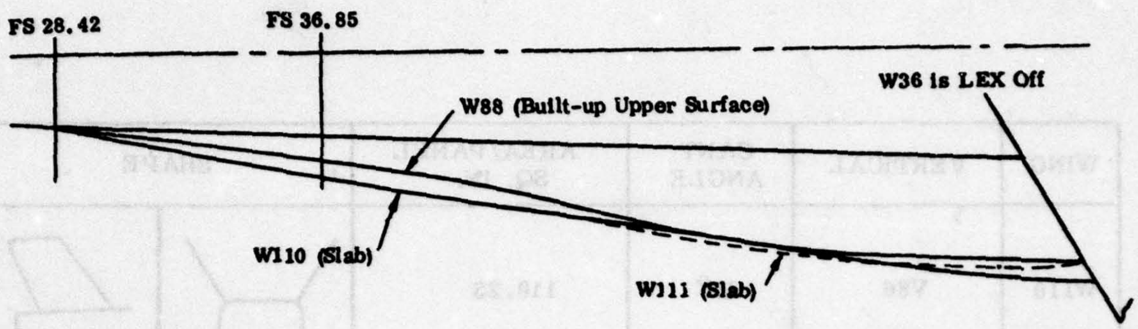


Figure 68. Small Planform Changes

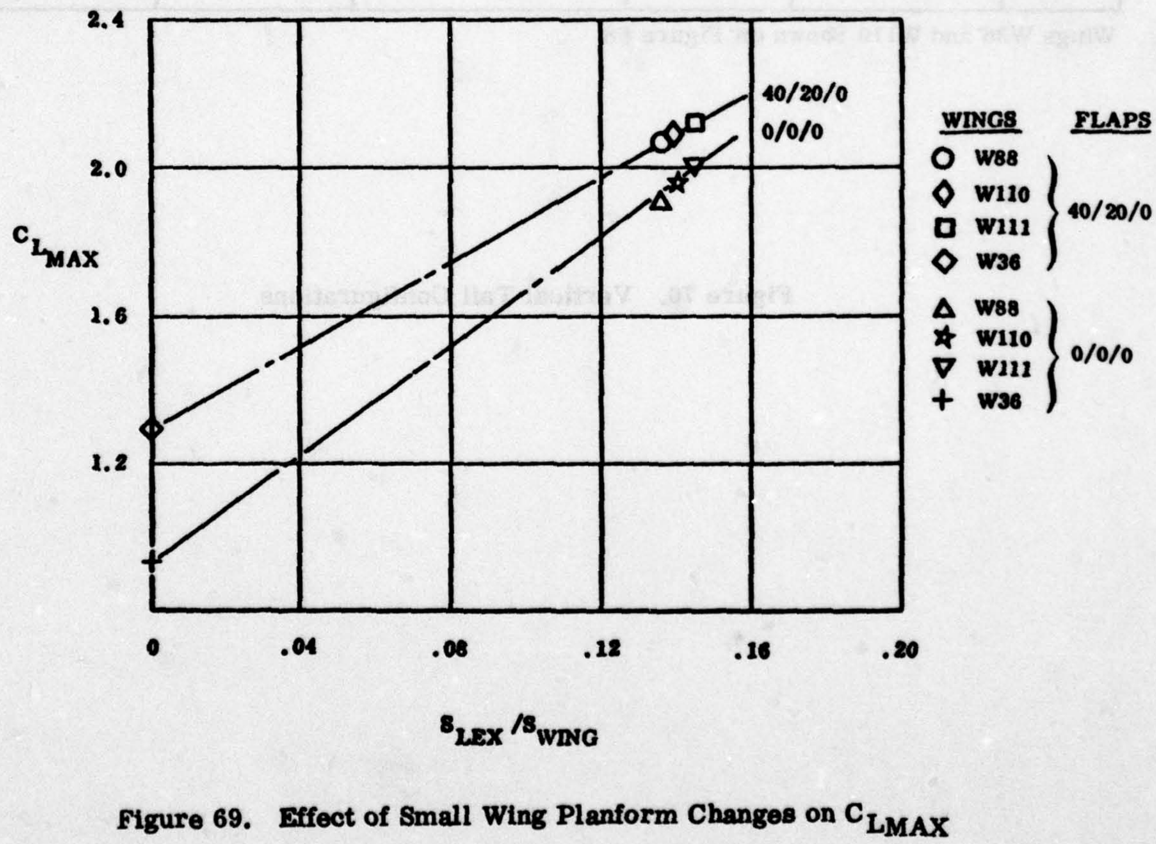
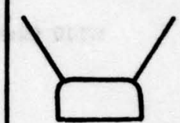
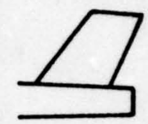
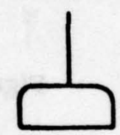
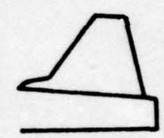


Figure 69. Effect of Small Wing Planform Changes on $C_{L_{MAX}}$

WING	VERTICAL	CANT ANGLE	AREA/PANEL SQ. IN.	SHAPE	
W110	V86	40^{o}	110.23		
W36	V99	0^{o}	127.22		

Wings W36 and W110 Shown on Figure 68

Figure 70. Vertical Tail Configurations

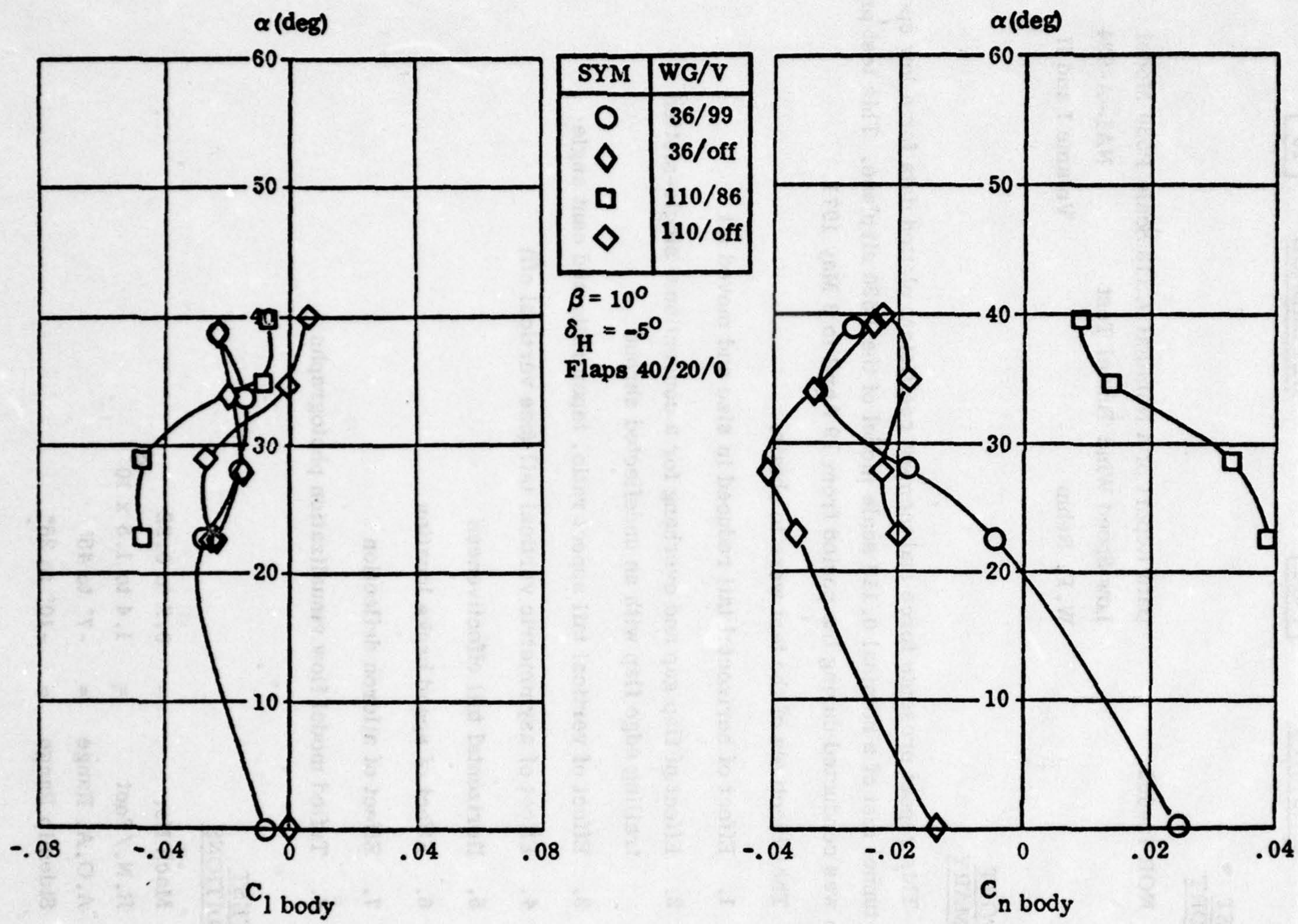


Figure 71. Effect of Vertical Tail

AIRCRAFT P530 **REFERENCE** 15

TEST REPORT

NOR 72-002 — Data Report of a Nominal 0.113 Scale P530 Model Low Speed Wind Tunnel Test NAL-A-934
W.P. Rehm — Volume I and II

REPORT SUMMARY

This report presents force and moment coefficient plotted data for a low speed wind tunnel test of a nominal 0.113 scale model of the P530 airplane. This test program was conducted during the period from 19 April to 8 May 1971.

The objectives of the test were to obtain:

1. Effect of horizontal tail reduced in size and moved aft
2. Effect of flap gap and overhang for a conventional single-slotted trailing edge flap with an undeflected shroud
3. Effect of vertical tail aspect ratio, taper ratio and cant angle
4. Effect of asymmetric vertical tail (one vertical off)
5. Horizontal tail effectiveness
6. Effect of speed brake location
7. Effect of aileron deflection
8. Tufted model flow visualization photographs

TEST CONDITIONS

Mach No.	=	0.2 to 0.22
R.N./Foot	=	1.4 to 1.5 x 10^6
A.O.A. Range	=	-7° to 45°
Sideslip Range	=	-10° to 28°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 64 in Reference 13. All tests were run with wing W88 (shown in Figure 68 in Reference 14.

CONFIGURATION CHANGES

A table of vertical tail configuration changes applicable to this study is shown in Figure 73.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 72 shows the effect on $C_{L_{MAX}}$ of flap settings 0/0/0 and 40/20/0 with wing W88.

Figure 74 shows the effect on lateral/directional stability of vertical tail cant angle V105, V108 and V109 with wing W88 and flaps 40/20/0. Lateral/directional stability is also shown in Figure 75 for the effect of vertical tail taper ratio and aspect ratio, V102-V104 with wing W88 and flaps 40/20/0. The effect of vertical tail lateral location V102 and V107 on lateral/directional stability is shown in Figure 76, and the effect of vertical tail longitudinal location V104-V106 in Figure 77.

Data for objectives 1, 2 and 4-8 listed above was either insufficient or not considered pertinent.

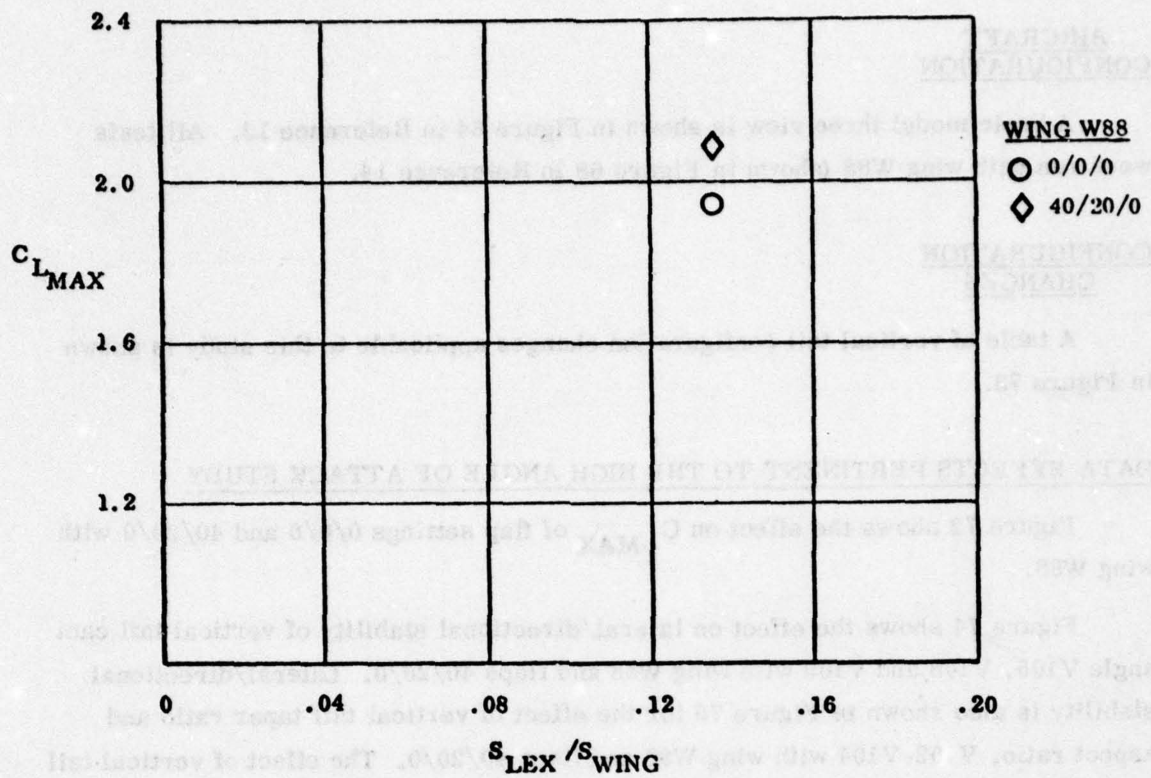


Figure 72. Effect of Flaps on $C_{L_{MAX}}$

VERTICAL	CANT ANGLE	Æ	.25c STATION	λ	ROOT B. L. LOC^n
102	30	1.2	82.96	.4	4.43
103	30	1.2	82.96	.5	4.43
104	30	1.4	82.96	.5	4.43
105	30	1.4	81.72	.5	4.43
106	30	1.4	84.31	.5	4.43
107	30	1.2	82.96	.4	3.48
108	20	1.4	81.72	.5	4.43
109	25	1.4	81.72	.5	4.43

All 110.2 Sq. In. Panel Area

Figure 73. Vertical Tail Configurations

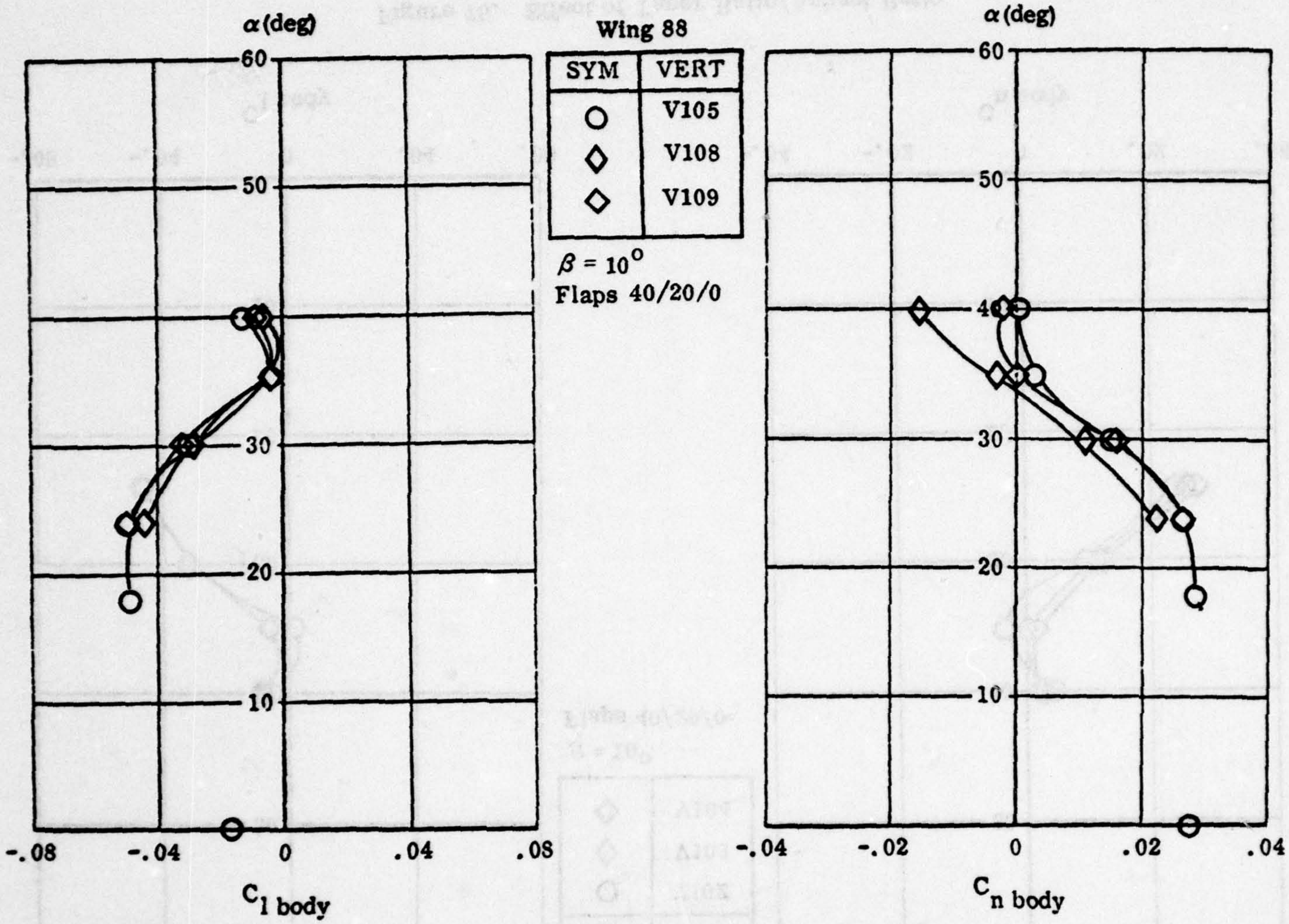


Figure 74. Effect of Cant Angle

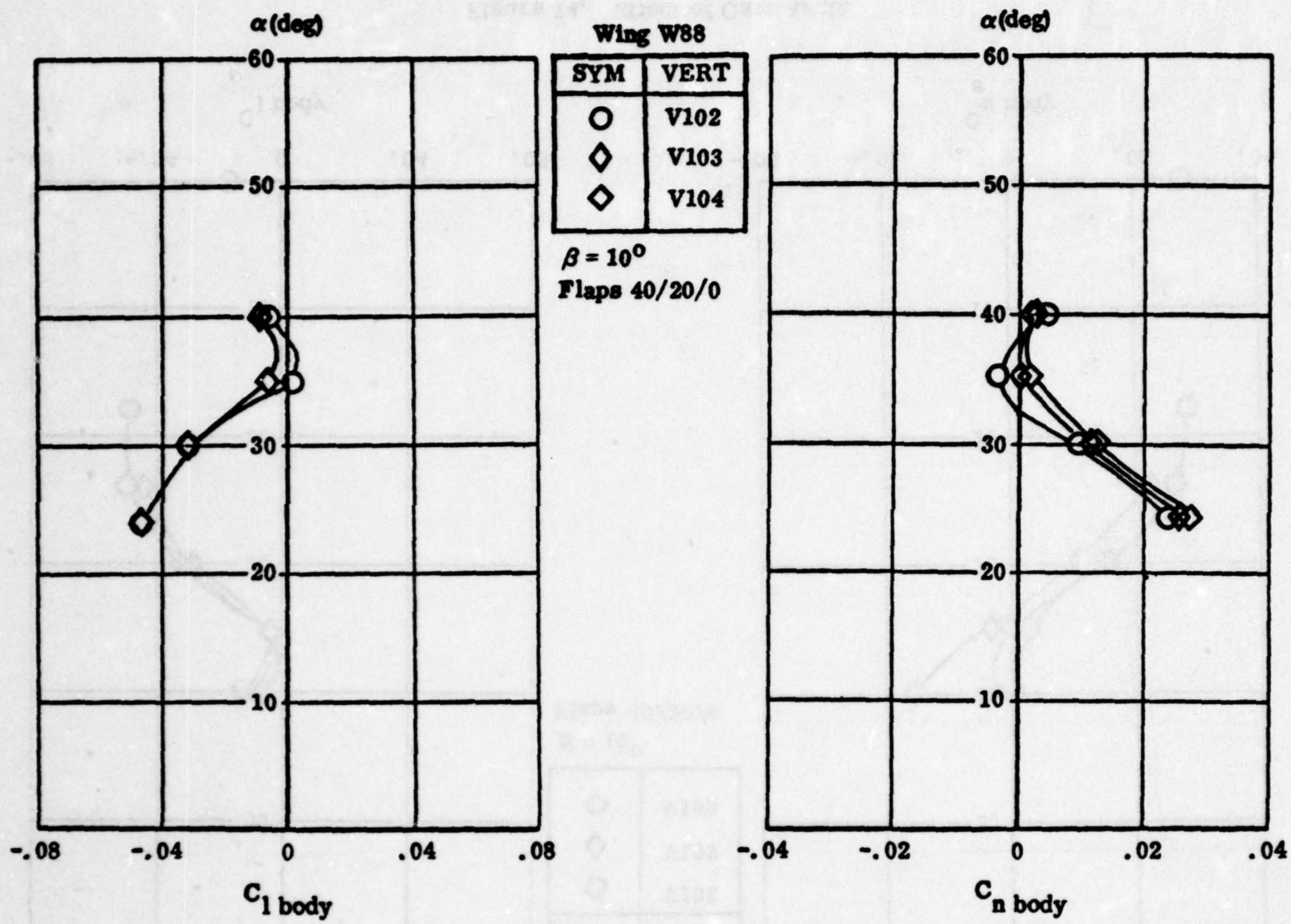


Figure 75. Effect of Taper Ratio/Aspect Ratio

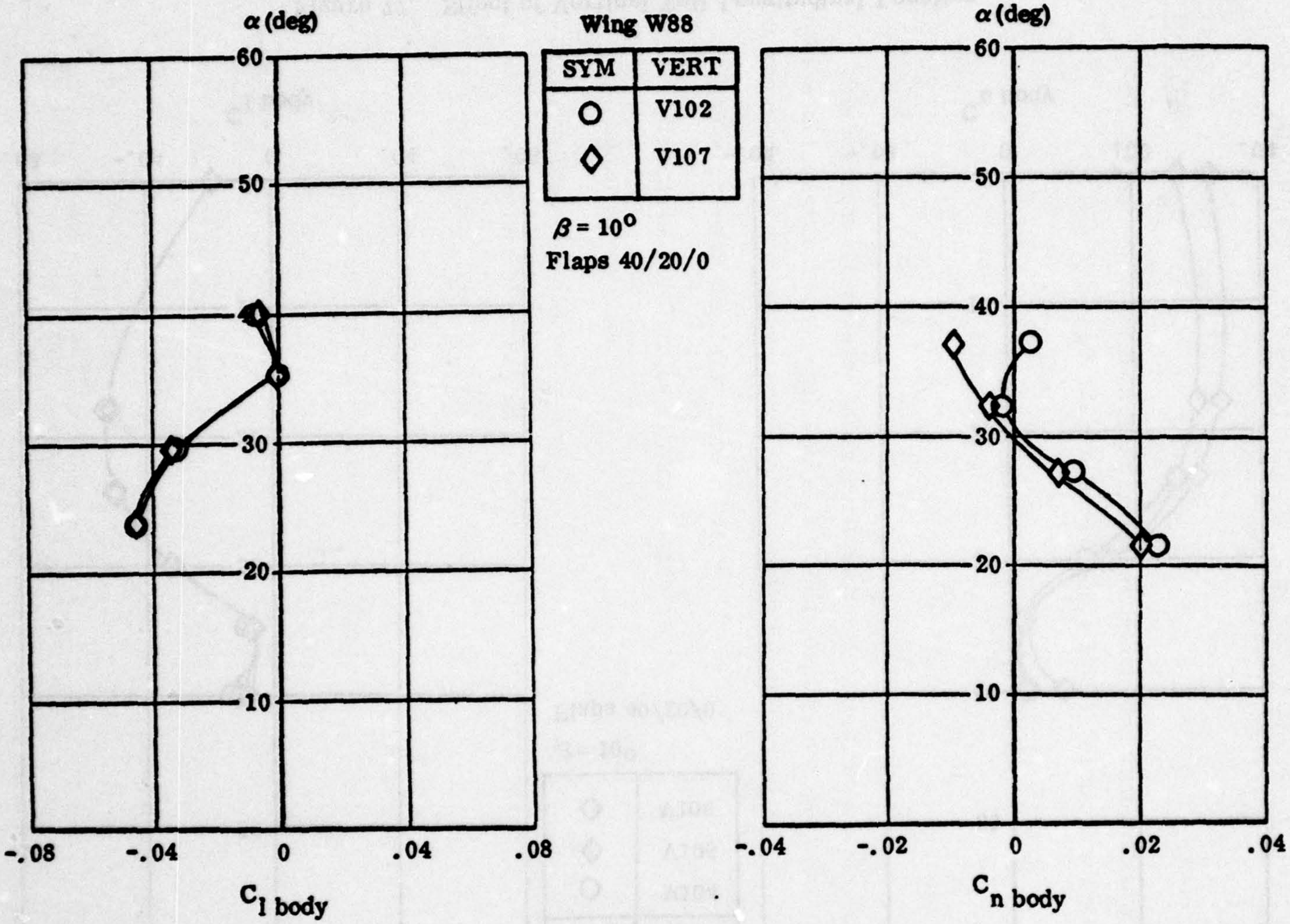


Figure 76. Effect of Vertical Tail Lateral Location

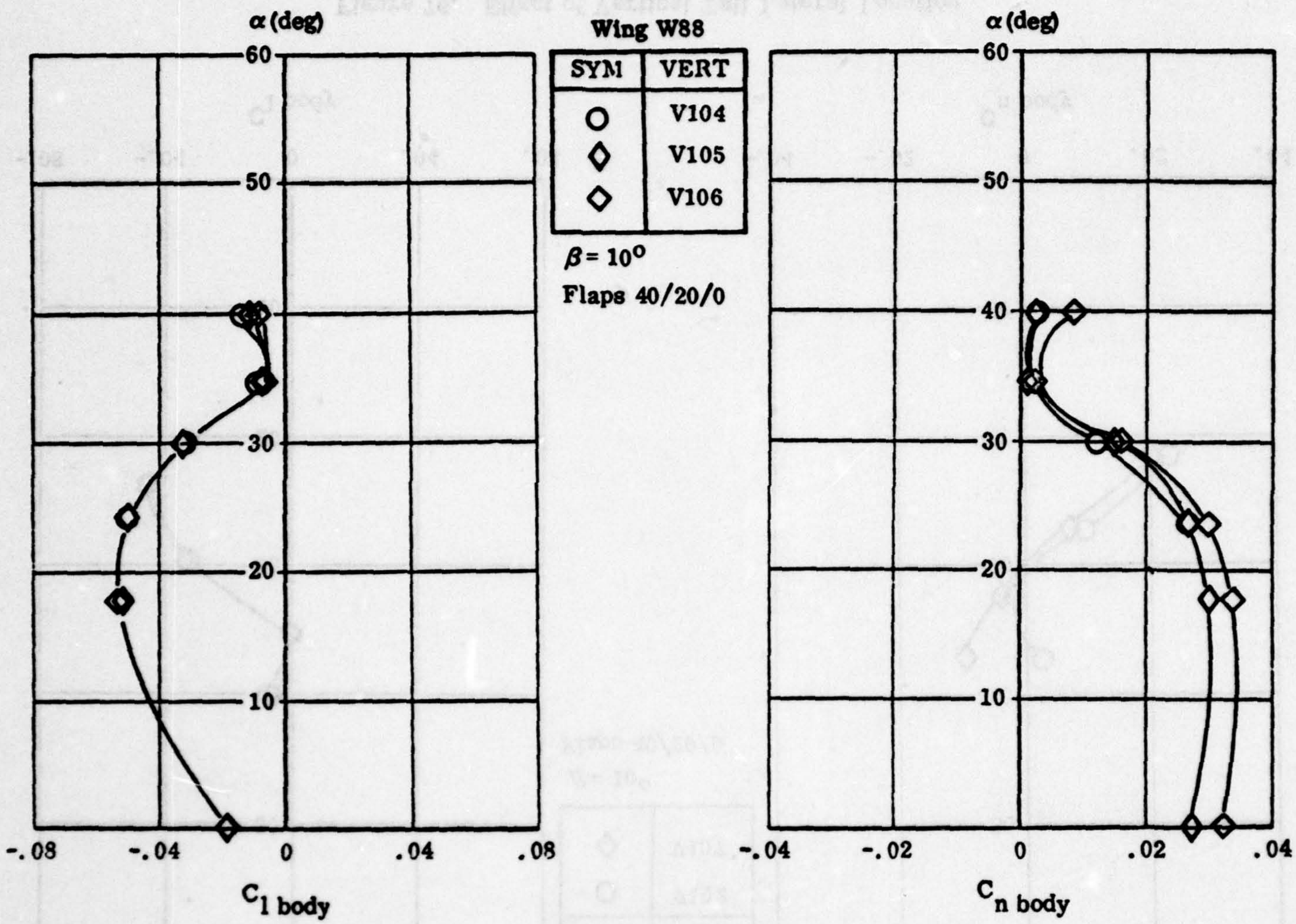


Figure 77. Effect of Vertical Tail Longitudinal Location

SECTION IV

P600 TESTS

The seven P600 low speed wind tunnel tests included in this survey were run between January 1972 and October 1973, and used a single 0.121 scale model. The basic configuration of this model was a mid-wing with a slightly smaller leading edge sweep, twin verticals in a forward position, with a cant angle of around 20 degrees.

All these tests were concerned with small wing and vertical changes, and for the first three tests, effects of various nose fuselages.

The latter tests were with a constant wing planform, and a large nose boom and nose strakes were added. Summaries of the seven low speed tests follow.

AIRCRAFT **P600** **REFERENCE** **16**

TEST REPORT

NOR 72-165	**Data Report of a Low Speed Wind Tunnel Test of 0.121 Scale P600 Force Model First Low Speed Test**
	A.D. Crandall

REPORT SUMMARY

This report presents force and moment coefficient data from a nominal 0.121 scale model of a P600 airplane configuration. The test program was conducted during the period 23 and 24 January 1972.

The objectives of the test were to obtain:

1. **Effect of Empennage Buildup**
2. **Horizontal Tail Effectiveness**
3. **Vertical Tail Position and Cant Angle**

TEST CONDITIONS

Mach No.	=	**0.22**
R.N./Foot	=	**1.5×10^6**
A.O.A. Range	=	**-6° to 40°**
Sideslip Range	=	**-10° to 25°**

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 78.

CONFIGURATION CHANGES

Sketches of vertical tail configuration changes applicable to this study are shown in Figure 79.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 80 shows the effect on lateral/directional stability of vertical tail cant angle V2 and V5, and the effect of vertical tail lateral location V4.

Data for objectives 1 and 2 listed above was either insufficient or not considered pertinent.

DIMENSIONS ARE MODEL SCALE

Wing Area = 5.102 Ft^2

M.A.C. = 15.6 in

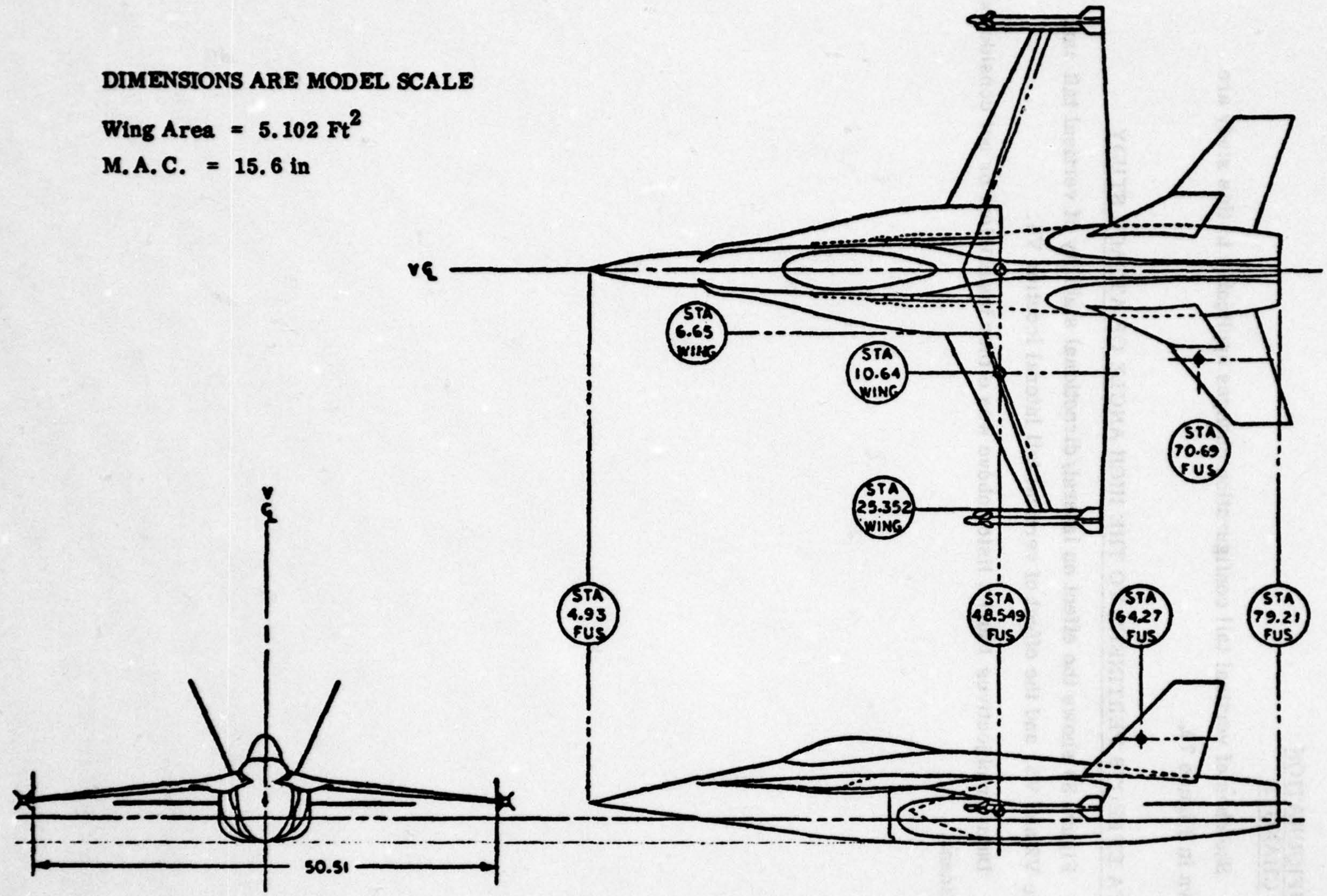


Figure 78. General Three View

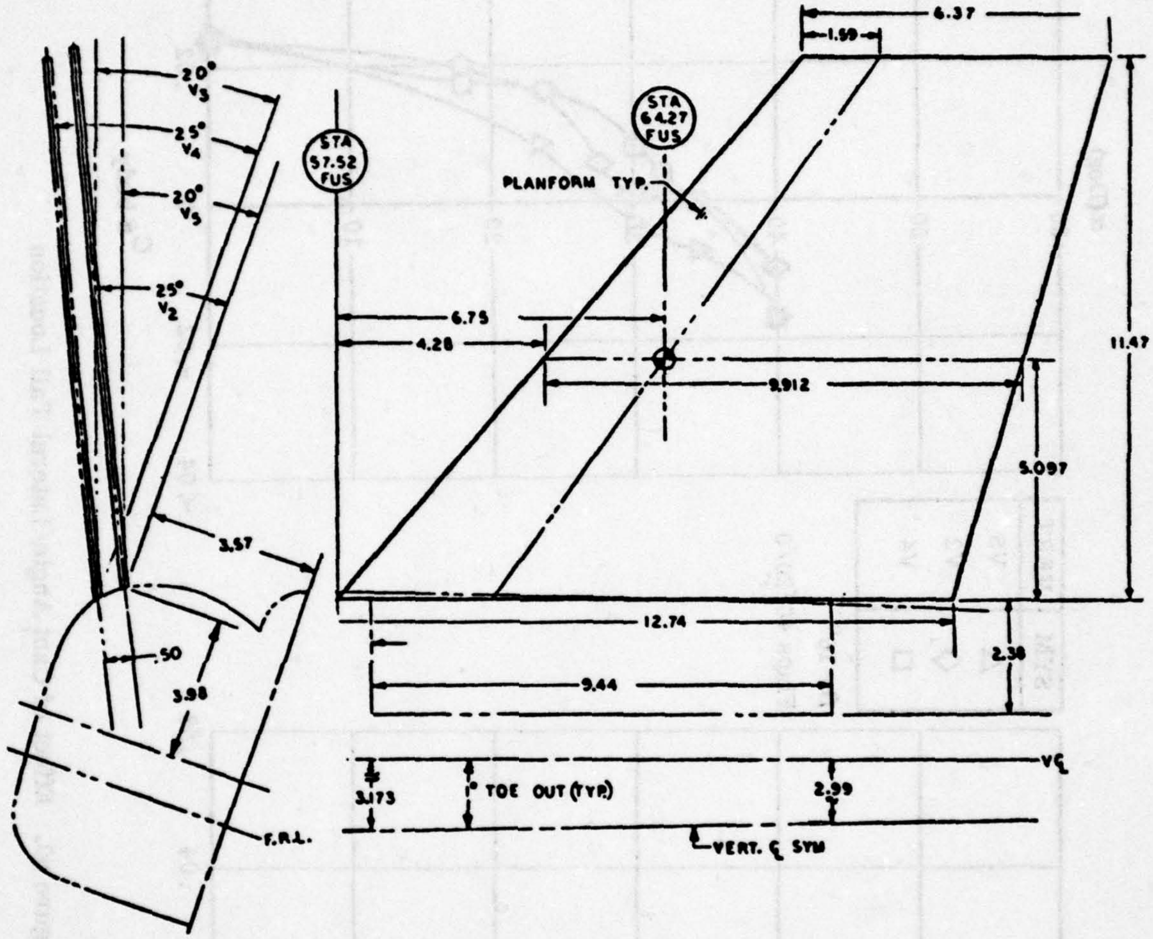


Figure 79. Vertical Tail Configurations

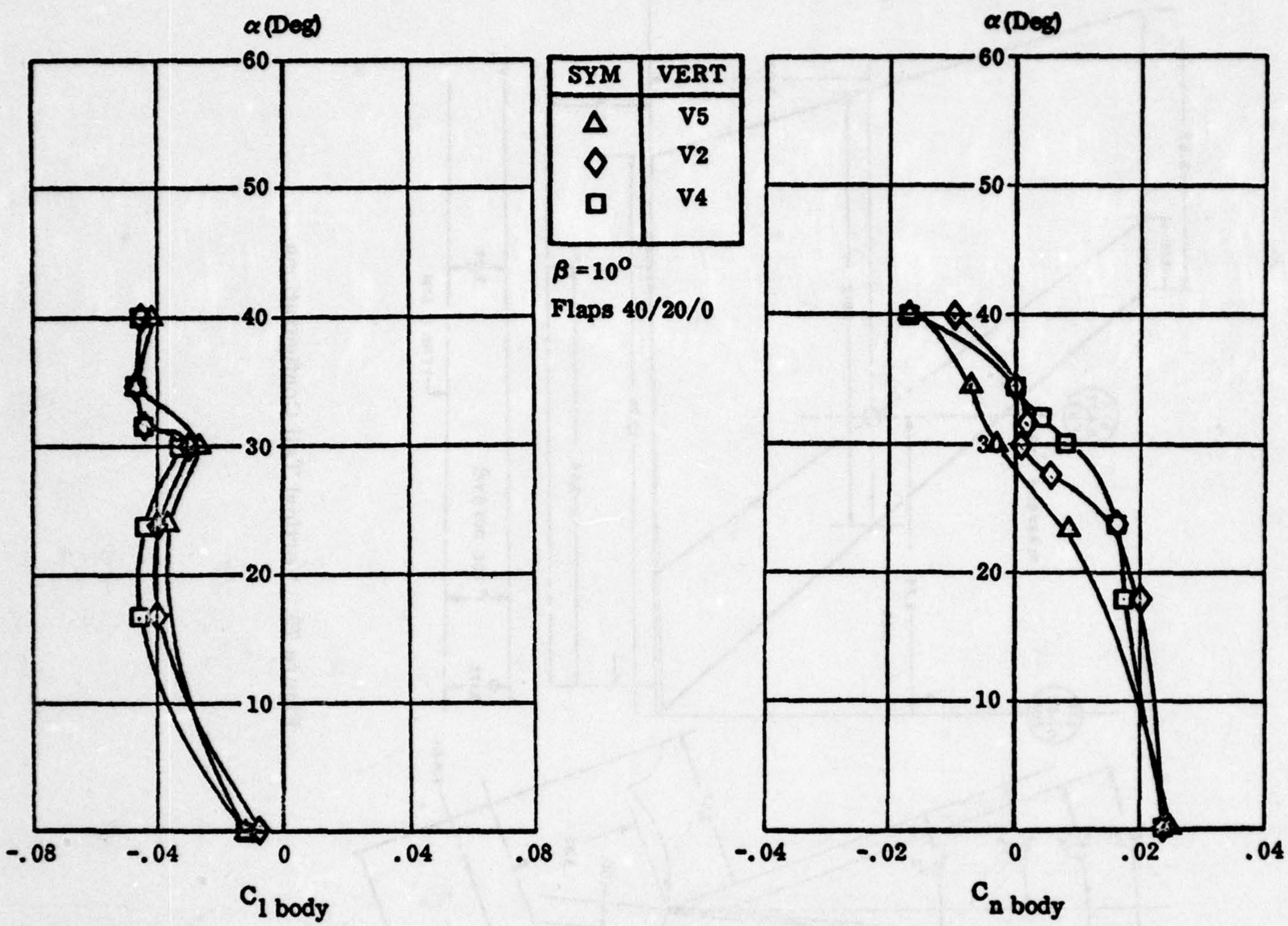


Figure 80. Effect of Cant Angle/Lateral Tail Location

AIRCRAFT P600 **REFERENCE** 17

TEST REPORT

NOR 72-166 — Data Report of a Low Speed Wind Tunnel Test of 0.121 Scale P600 Force Model Second Low Speed Test

A.D. Crandall

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a nominal 0.121 scale model of a P600 airplane configuration. The test was conducted during the period from 3 through 5 February 1972.

The objectives of the test were to obtain:

1. Comparison of wing leading edge extensions
2. Empennage buildup
3. Horizontal tail effectiveness
4. Comparison of horizontal tails
5. Comparison of vertical tails
6. Aileron effectiveness
7. Lateral-directional characteristics in sideslip

TEST CONDITIONS

Mach No.	=	0.22
R.N./Foot	=	1.5×10^6
A.O.A. Range	=	-6° to 40°
Sideslip Range	=	-10° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 81.

CONFIGURATION CHANGES

Sketches of LEX planform configuration changes applicable to this study are shown in Figure 82.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 83 shows the effect on $C_{L_{MAX}}$ of the following:

LEX W42 with flaps 0/0/0 and 40/20/0;

LEX length, W37-W40 with flaps 40/20/0.

Data for objectives 2-7 listed above was either insufficient or not considered pertinent.

DIMENSIONS ARE MODEL SCALE

Wing Area = 5.102 Ft^2

M. A. C. = 15.6 in

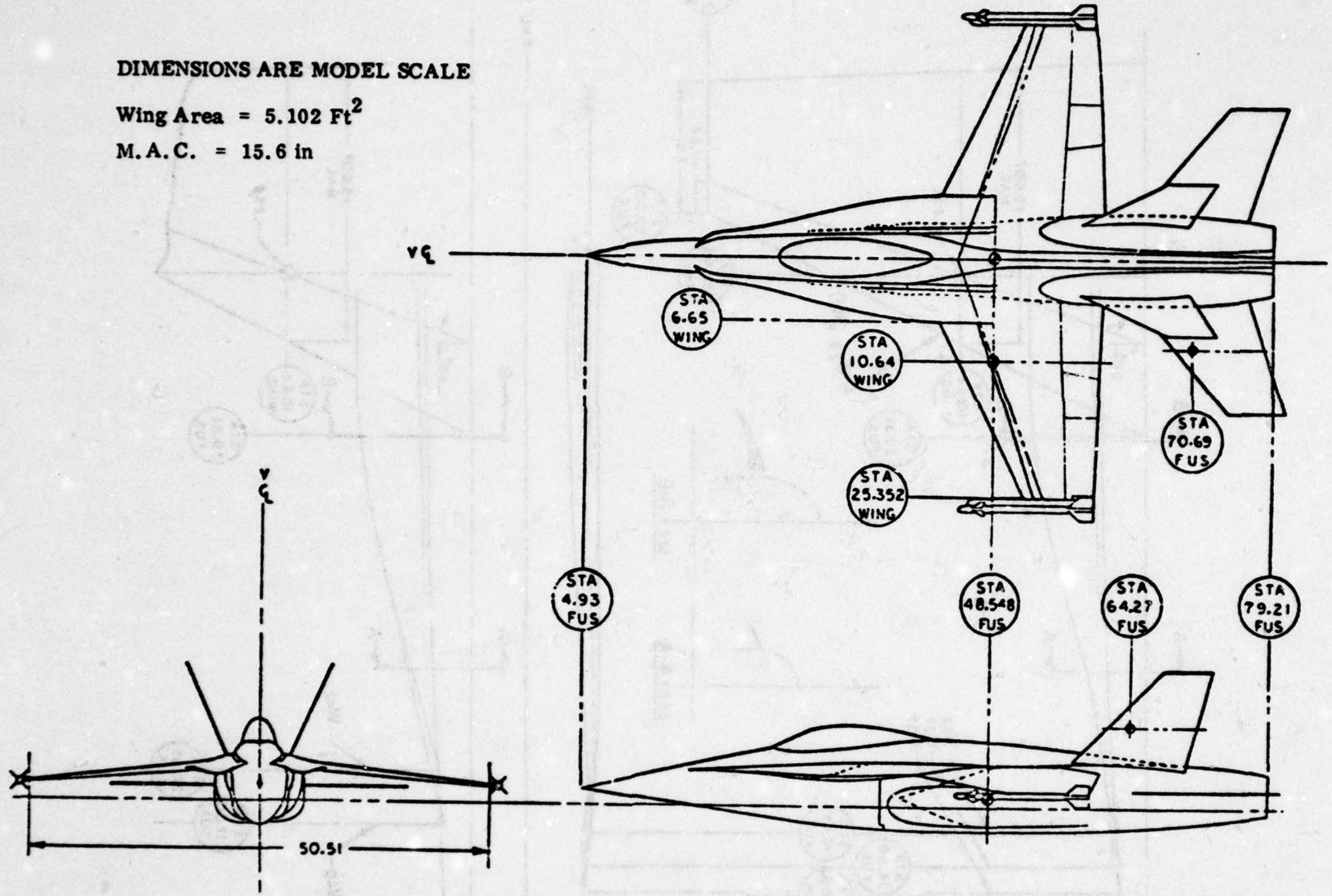


Figure 81. General Three View

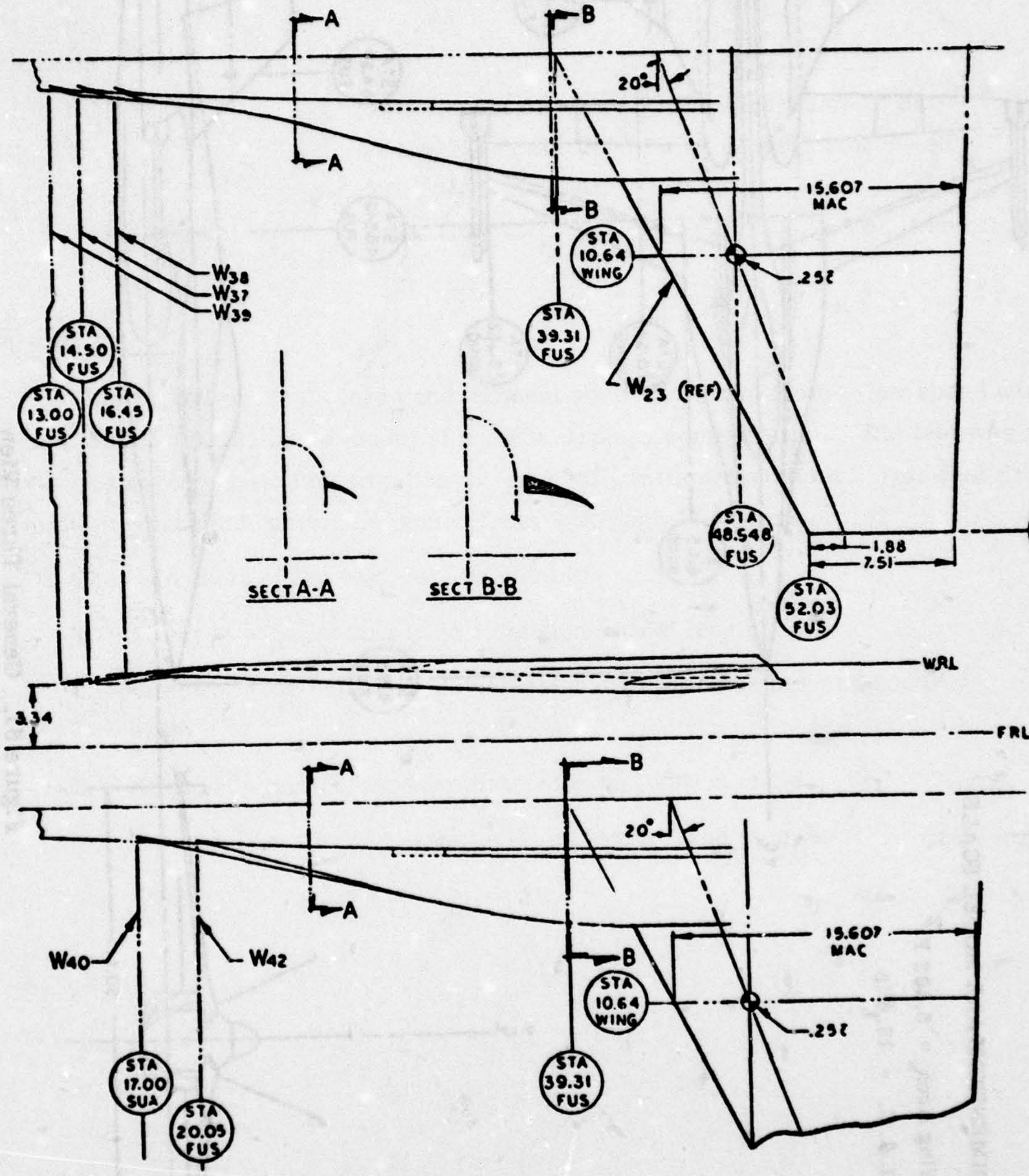


Figure 82. LEX Planform Variation

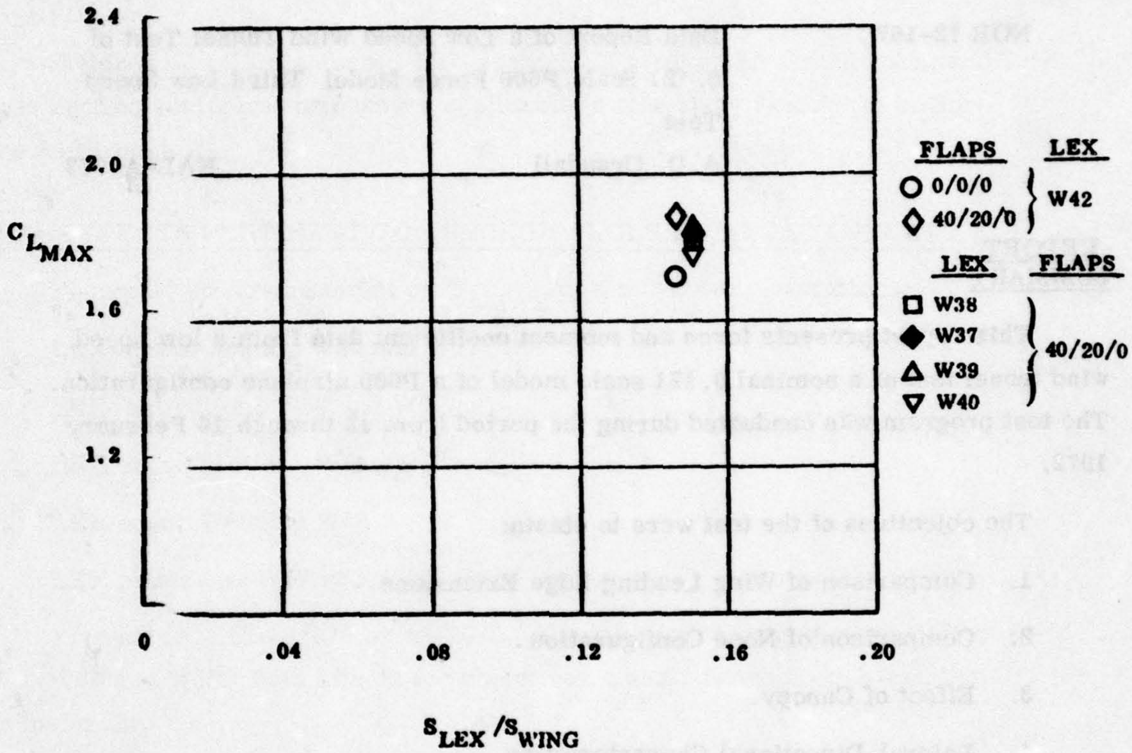


Figure 83. Effect of LEX Planform and Effect of Flaps on $C_{L_{MAX}}$

AIRCRAFT $\boxed{\text{P600}}$ **REFERENCE** $\boxed{\text{18}}$

TEST REPORT

NOR 72-167 Data Report of a Low Speed Wind Tunnel Test of 0.121 Scale P600 Force Model Third Low Speed Test

A.D. Crandall NAL-A-973

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a nominal 0.121 scale model of a P600 airplane configuration. The test program was conducted during the period from 12 through 16 February 1972.

The objectives of the test were to obtain:

1. Comparison of Wing Leading Edge Extensions
2. Comparison of Nose Configuration
3. Effect of Canopy
4. Lateral-Directional Characteristics
5. Effect of Vertical Tail Cant Angle

TEST CONDITIONS

Mach No.	=	0.22
R. N./Foot	=	1.5×10^6
A. O. A. Range	=	-6° to 40°
Sideslip Range	=	-10° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 84.

CONFIGURATION CHANGES

Sketches of LEX angle and LEX strake configuration changes applicable to this study are shown in Figures 85 and 86.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 87 shows the effect on $C_{L_{MAX}}$ of LEX strakes W50 and W52, and LEX angle variations W45 and W46. Flap setting was 40/20/0.

Data for objectives 2 through 5 listed above was either insufficient or not considered pertinent.

DIMENSIONS ARE MODEL SCALE

Wing Area = 5.102 Ft^2

M.A.C. = 15.6 in

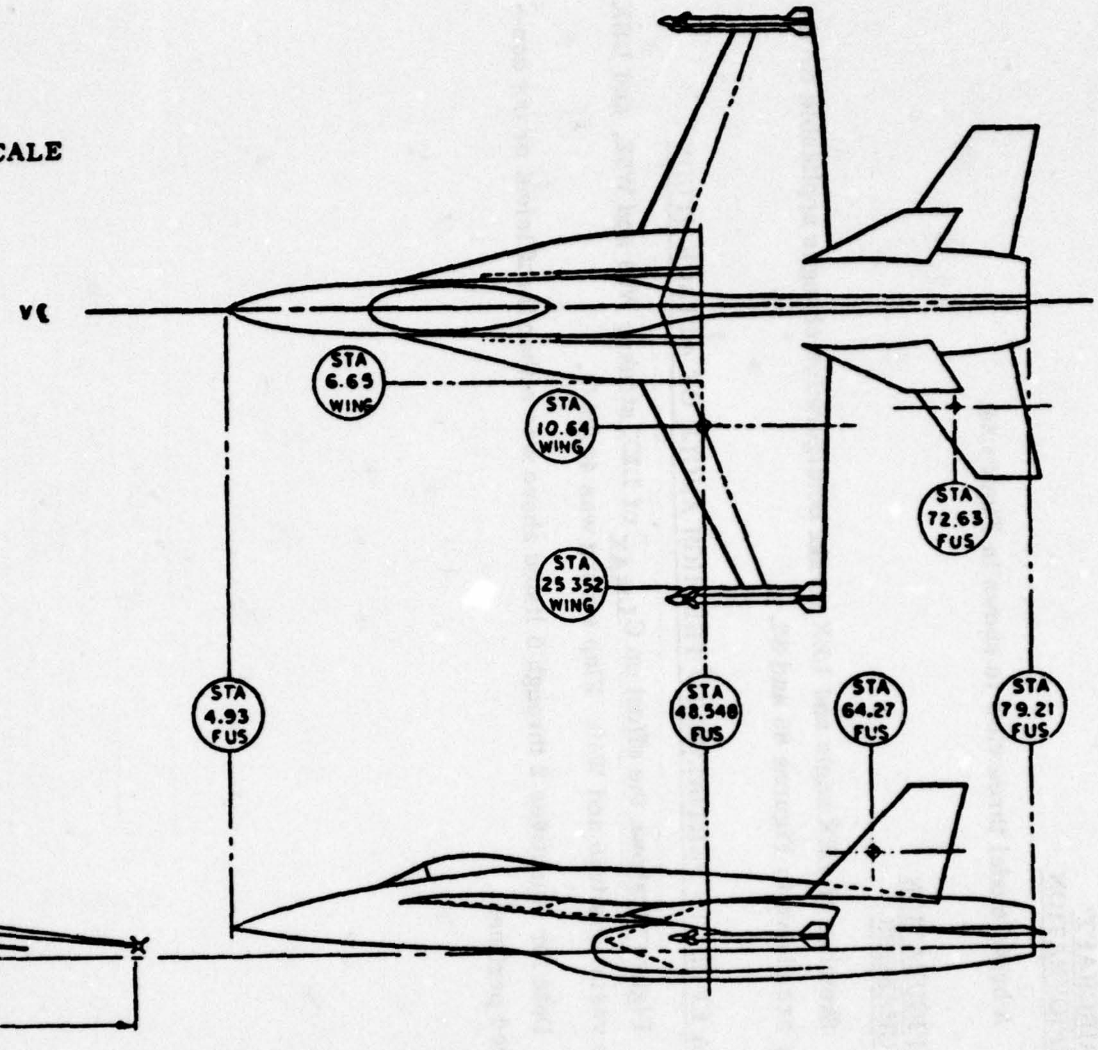


Figure 84. General Three View

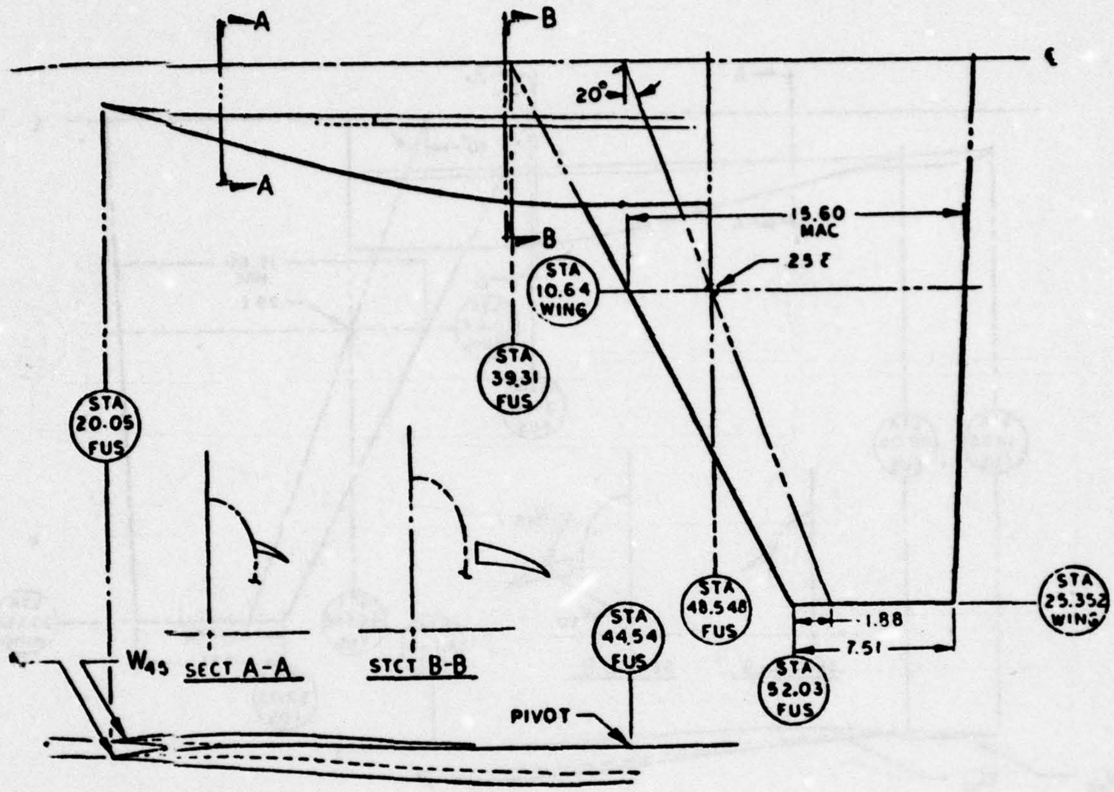


Figure 85. LEX Angle Variation (W45, 46)

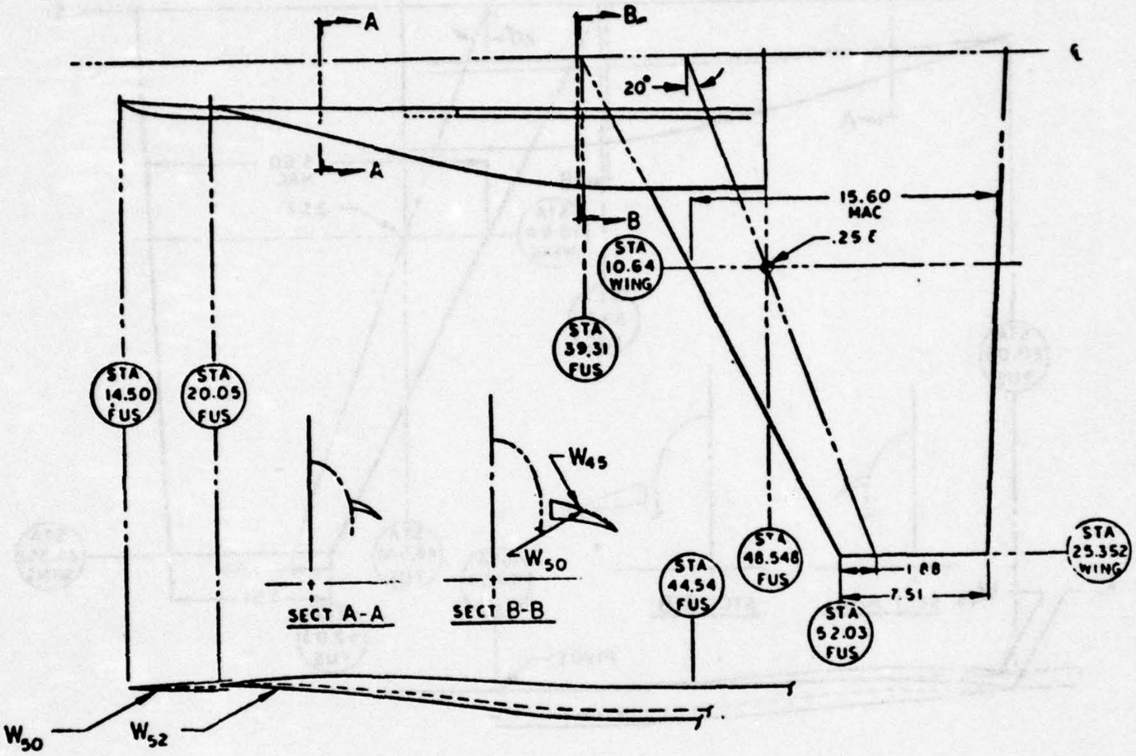


Figure 86. LEX Strake Variation (W50, 52)

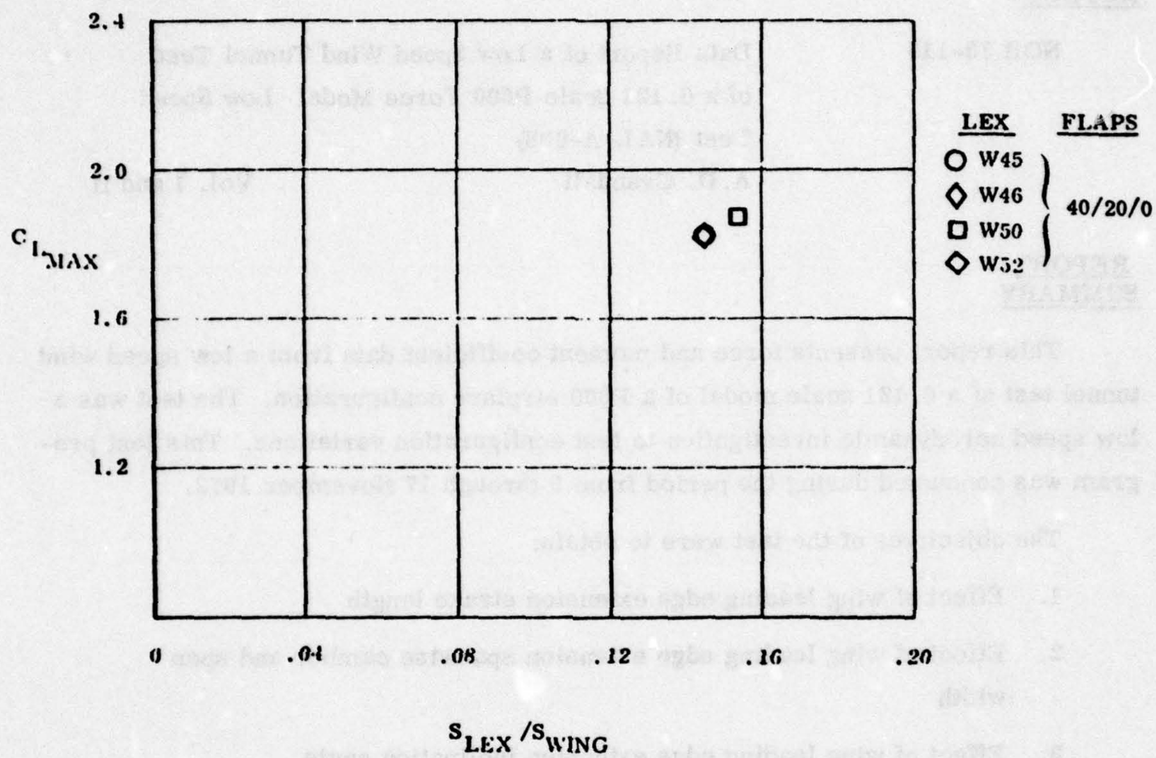


Figure 87. Effect of LEX Angle and LEX Strake on $C_{L_{MAX}}$

AIRCRAFT P600 **REFERENCE** 19

TEST REPORT

NOR 73-115	Data Report of a Low Speed Wind Tunnel Test of a 0.121 Scale P600 Force Model Low Speed Test (NAL-A-008)
A.D. Crandall	Vol. I and II

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 0.121 scale model of a P600 airplane configuration. The test was a low speed aerodynamic investigation to test configuration variations. This test program was conducted during the period from 9 through 17 November 1972.

The objectives of the test were to obtain:

1. Effect of wing leading edge extension strake length
2. Effect of wing leading edge extension spanwise camber and span width
3. Effect of wing leading edge extension inclination angle
4. Lateral-Directional characteristics in pitch and sideslip
5. Effect of Reynolds number

TEST CONDITIONS

Mach No.	=	0.22
R.N./Foot	=	1.5×10^6
A.O.A. Range	=	-6° to 40°
Sideslip Range	=	-10° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 88.

CONFIGURATION CHANGES

Sketches of LEX planform, LEX span, LEX strake, LEX inclination and LEX cross section configuration changes applicable to this study are shown in Figures 89 through 93.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 94 shows the effect on $C_{L_{MAX}}$ of the following variations:

LEX strake length, W54 and W57

LEX inclination, W57 and W64

LEX cross section, W54, W58 and W59

LEX span, W66 and W68

LEX planform, W67 and W69

Flap settings are 0/0/0 or 40/20/0. Available pitch data shows no effect of W54, W66 and W68. Data effects for objectives 4 and 5 listed above were insufficient for inclusion.

DIMENSIONS ARE MODEL SCALE

Wing Area = 5.102 Ft^2

M.A.C. = 15.65 in

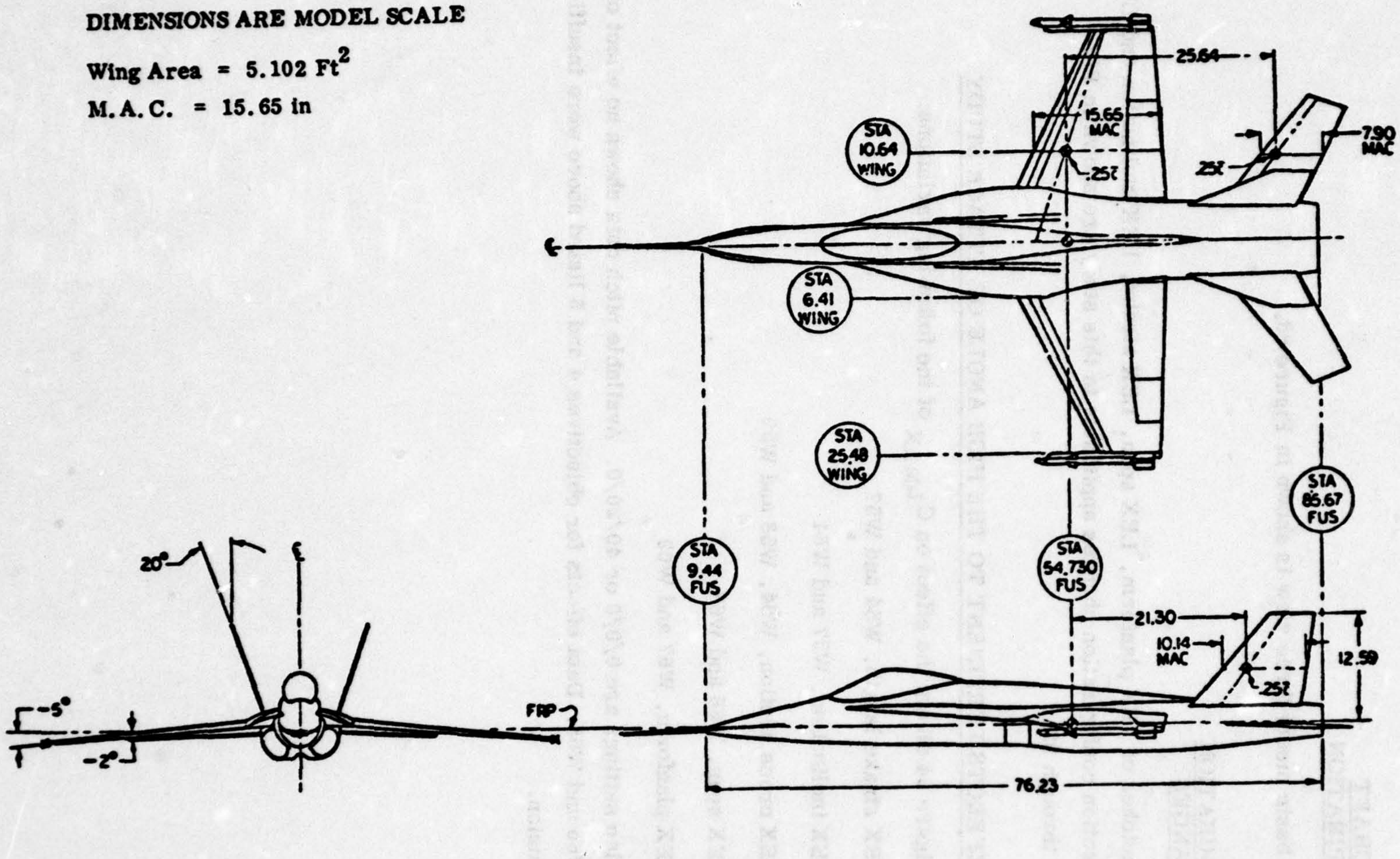


Figure 88. General Three View

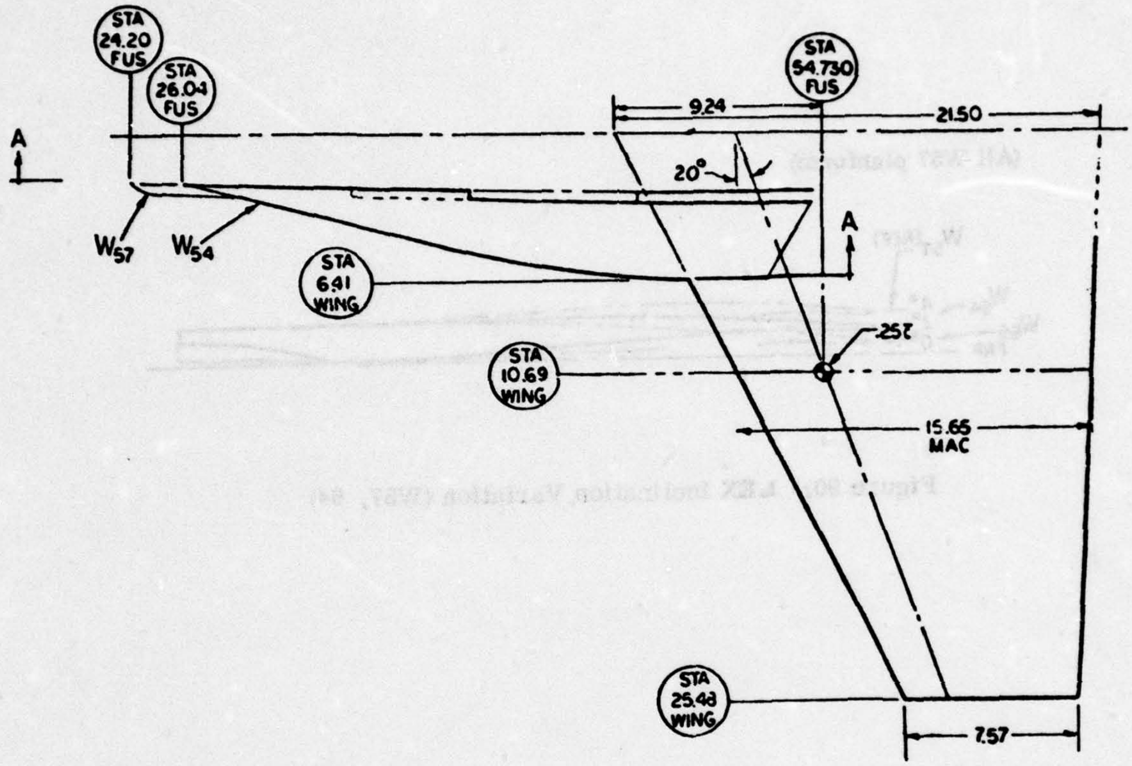


Figure 89. LEX Strake Length Variation (W54, 57)

(All W57 planform)

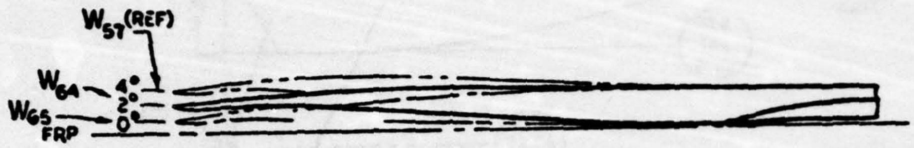
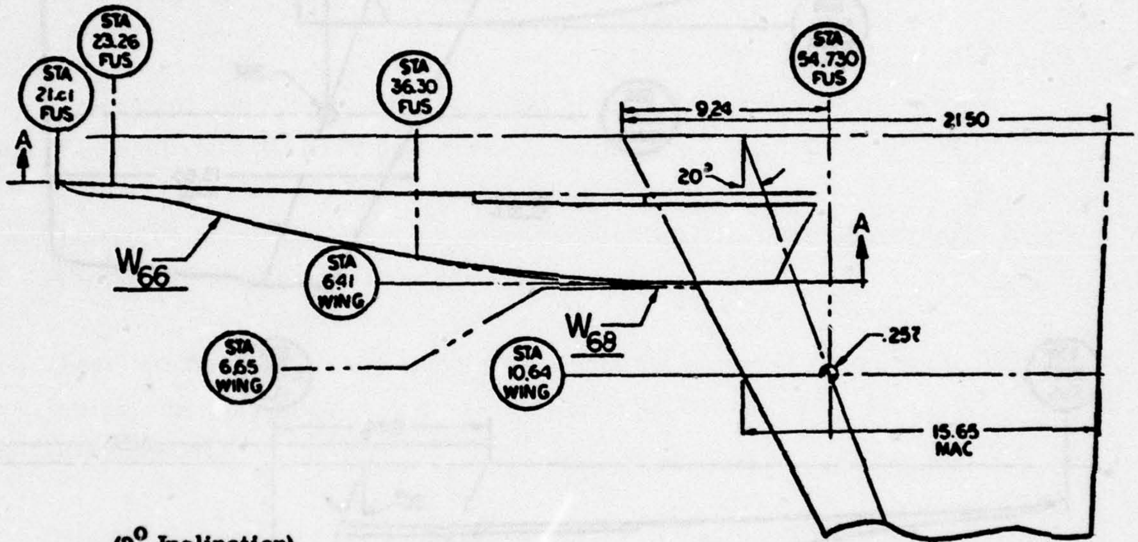


Figure 90. LEX Inclination Variation (W57, 64)

W54	Cambered Undersurface
W58	Flat Undersurface
W59	Slight Camber on Lower Surface

(All W54 Planform)

Figure 91. LEX Cross Section Variation (W54, 58, 59)



(2° Inclination)

Figure 92. Increasing LEX Span (W66, 68)

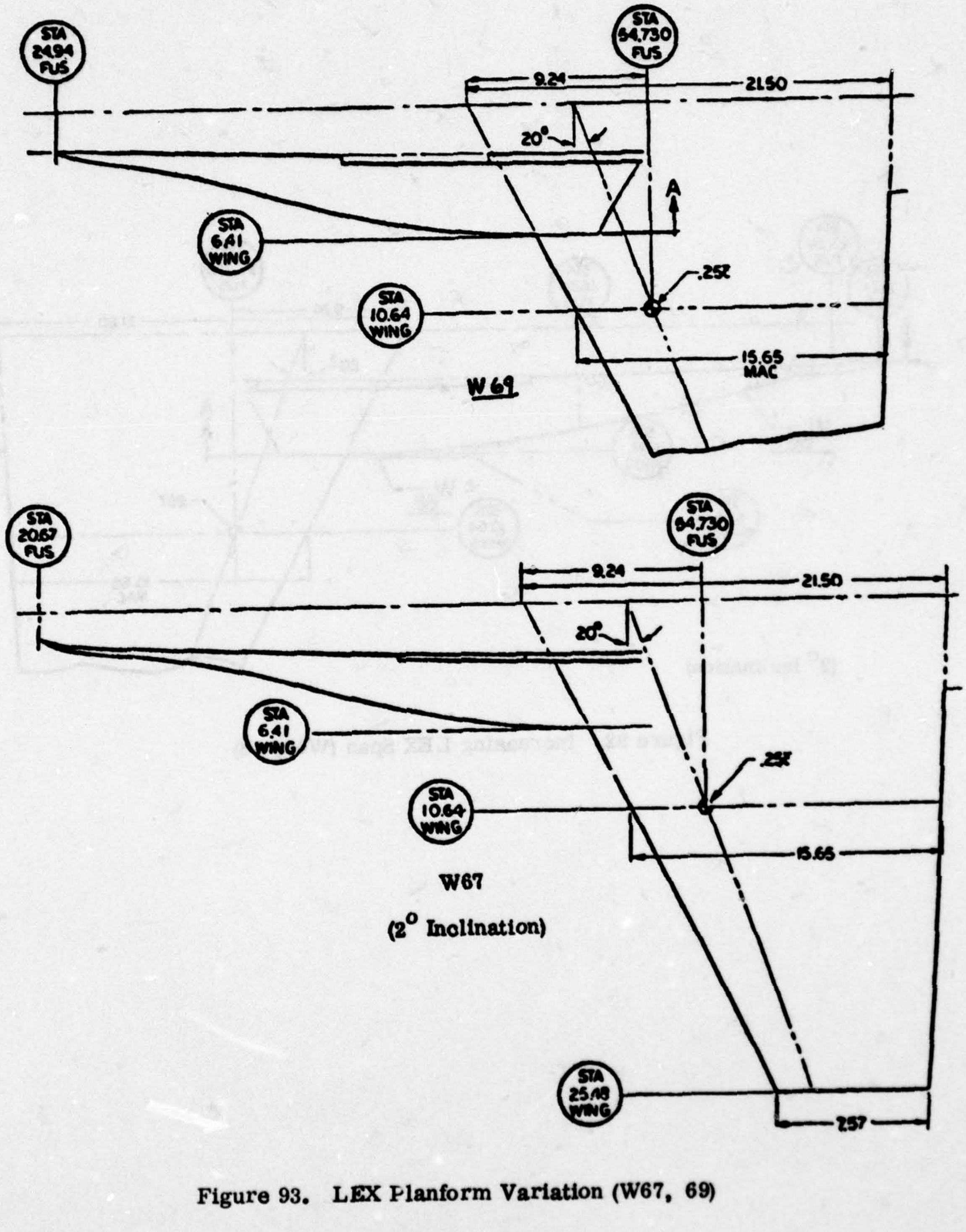


Figure 93. LEX Planform Variation (W67, 69)

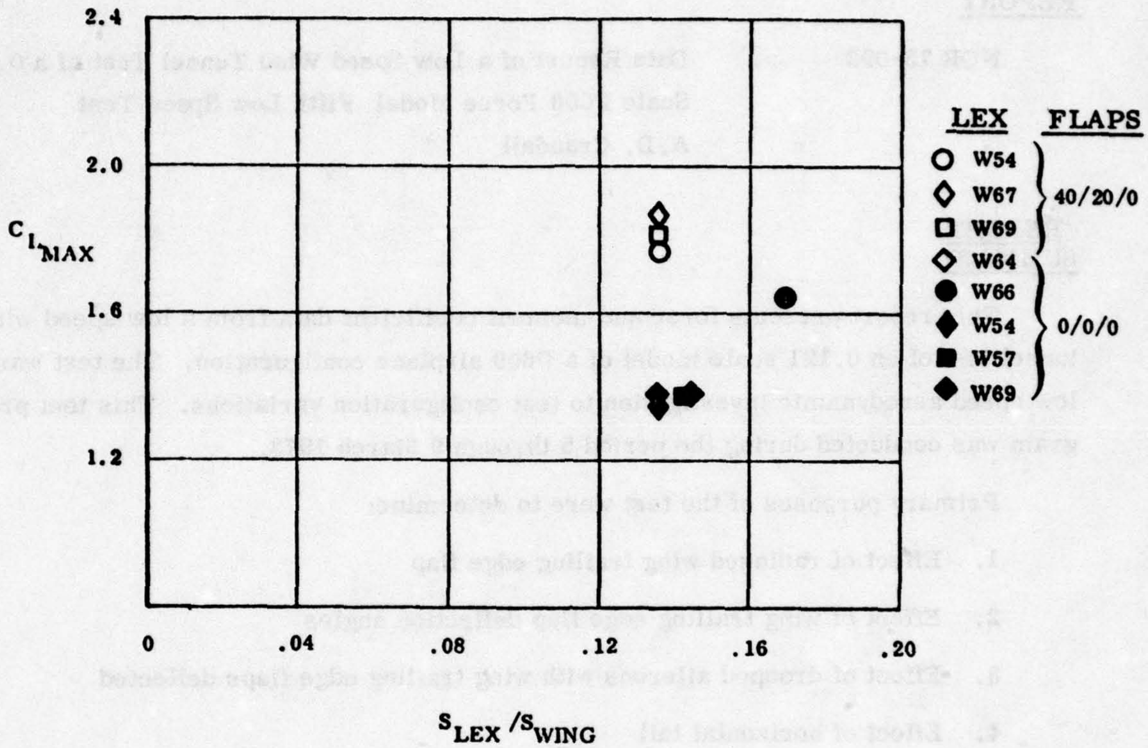


Figure 94. LEX Effects on $C_{L_{MAX}}$

AIRCRAFT P600 REFERENCE 20

TEST REPORT

NOR 73-092 — Data Report of a Low Speed Wind Tunnel Test of a 0.121 Scale P600 Force Model Fifth Low Speed Test

A.D. Crandall

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of an 0.121 scale model of a P600 airplane configuration. The test was a low speed aerodynamic investigation to test configuration variations. This test program was conducted during the period 5 through 9 March 1973.

Primary purposes of the test were to determine:

1. Effect of radiused wing trailing edge flap
2. Effect of wing trailing edge flap deflection angles
3. Effect of drooped ailerons with wing trailing edge flaps deflected
4. Effect of horizontal tail
5. Effect of aerodynamic hysteresis

TEST CONDITIONS

Mach No.	= 0.18
R.N./Foot	= 1.3×10^6
A.O.A. Range	= Various
Sideslip Range	= -10° to 10°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 95.

CONFIGURATION CHANGES

A sketch of wing W54 applicable to the study is shown in Figure 89.

CATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 96 shows the effect on $C_{L_{MAX}}$ of wing W54 with flap settings of 25°/30° and 25°/20°.

Data effects for objectives 1 and 3-5 listed above were insufficient for inclusion.

DIMENSIONS ARE MODEL SCALE

Wing Area = 5.102 Ft^2

M.A.C. = 15.65 in

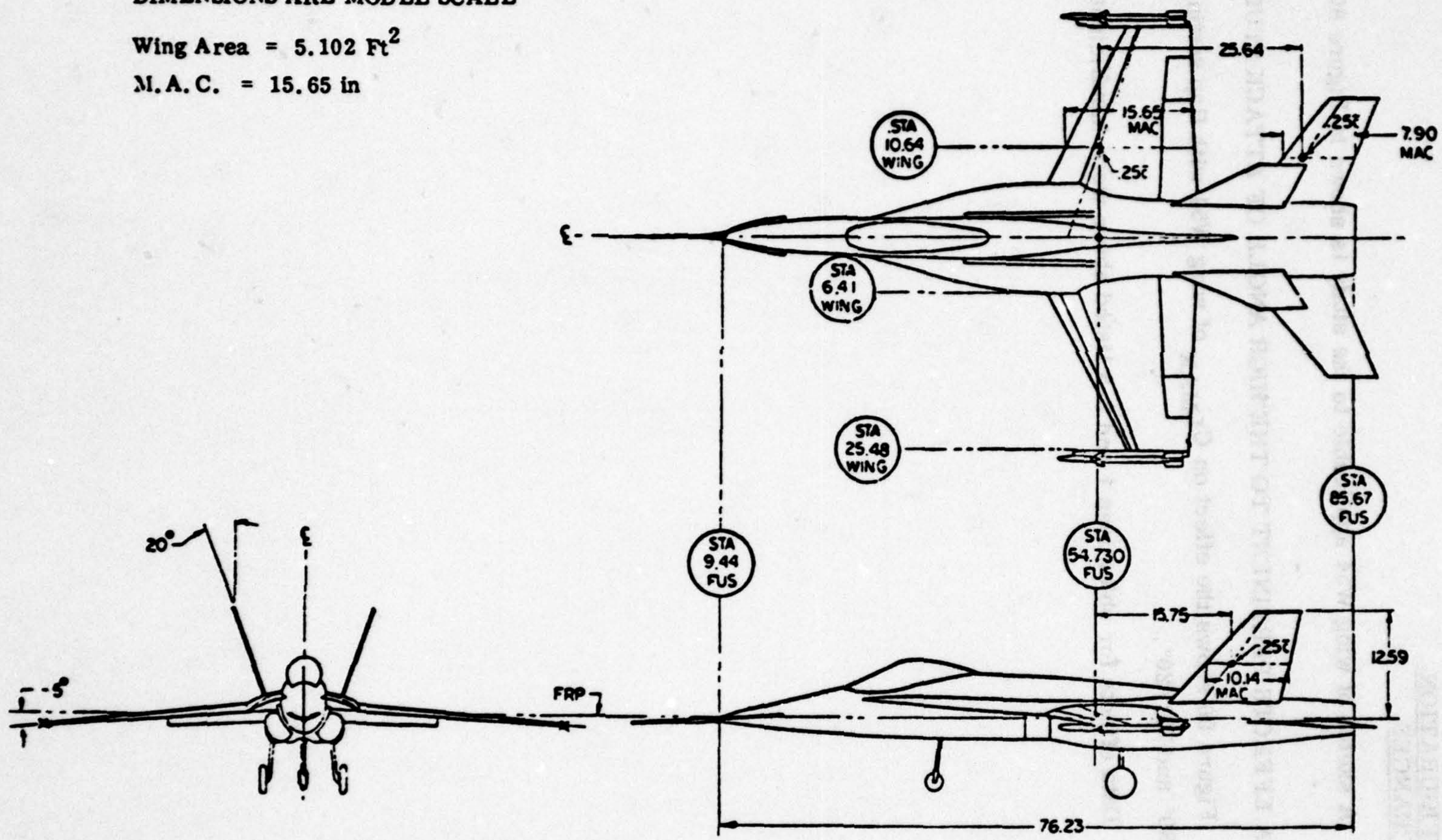


Figure 95. General Three View

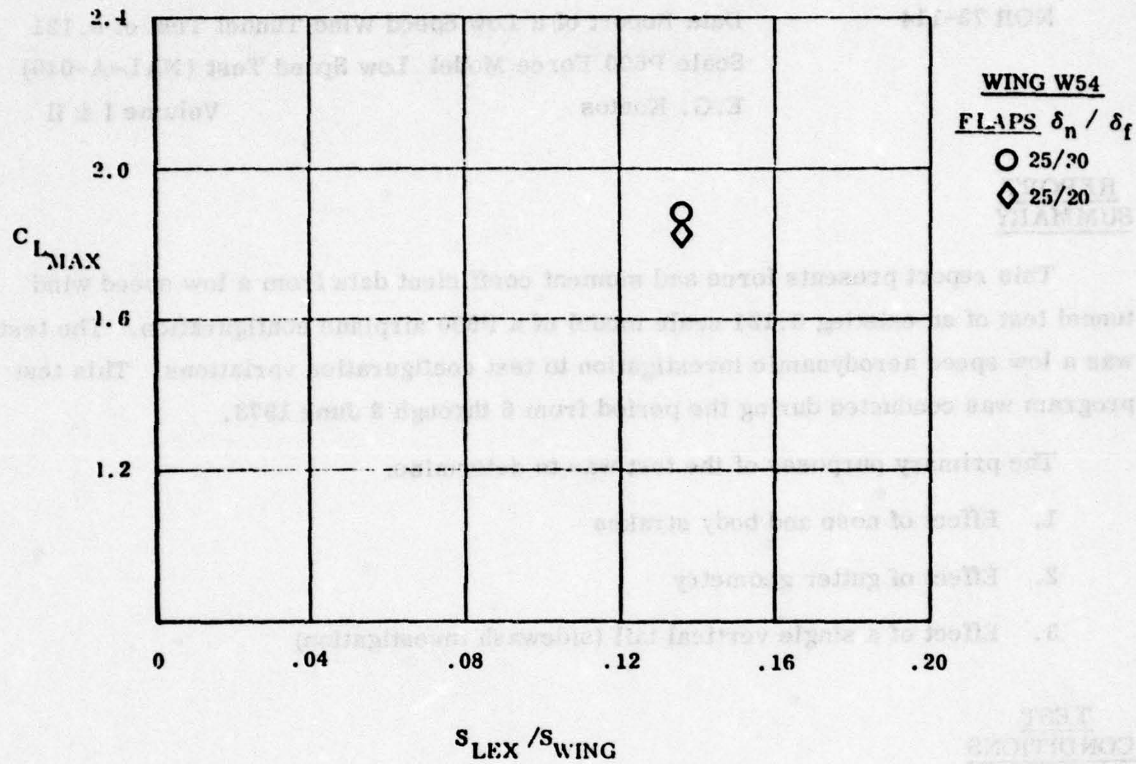


Figure 96. Effect of Flaps on $C_{L_{Max}}$

AIRCRAFT P600 **REFERENCE** 21

TEST REPORT

NOR 73-114 — Data Report of a Low Speed Wind Tunnel Test of 0.121 Scale P600 Force Model Low Speed Test (NAL-A-046)

E.G. Kontos — Volume I & II

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of an existing 0.121 scale model of a P600 airplane configuration. The test was a low speed aerodynamic investigation to test configuration variations. This test program was conducted during the period from 6 through 8 June 1973.

The primary purposes of the test was to determine:

1. Effect of nose and body strakes
2. Effect of gutter geometry
3. Effect of a single vertical tail (sidewash investigation)

TEST CONDITIONS

Mach No.	= 0.18
R.N./Foot	= 1.3×10^6
A.O.A. Range	= -6° to 40°
Sideslip Range	= -10° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 97. All runs were with wing W54 shown in Figure 89.

CONFIGURATION CHANGES

Sketches of strakes, strake angle variation, strake cross section variation and vertical tail configuration changes applicable to this study are shown in Figures 98, 99 and 103.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 100 shows the effect on lateral/directional stability of body strake S24, S25 and strakes off. These configurations tested included wing W54 and nose strake S19.

Figures 101 and 102 show the pitch effect and lateral/directional stability effect of nose strakes S19, S23 and strake off with wing W54.

Figure 104 shows the effect on lateral/directional stability of the single vertical tail V34 with nose strake S19 and wing W54.

There was no effect on the sideslip data obtained for nose strake angle S19 through S-22, and for nose strake cross-section S19, S23 and S26. This testing included wing W54.

Data effects for objective 2, gutter geometry, were insufficient for inclusion.

DIMENSIONS ARE MODEL SCALE

Wing Area = 5.102 Ft^2

M.A.C. = 15.65 in

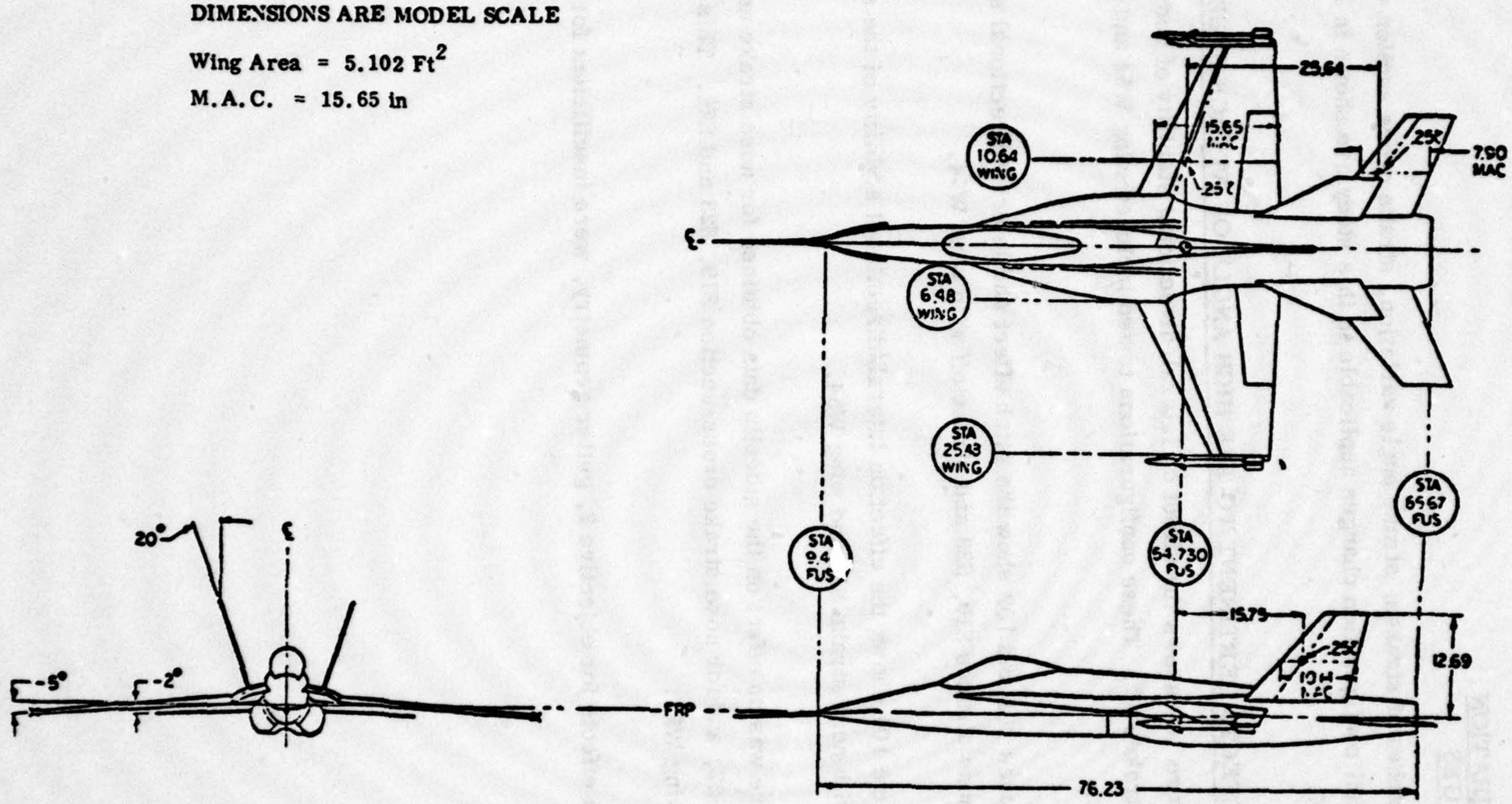


Figure 97. General Three View

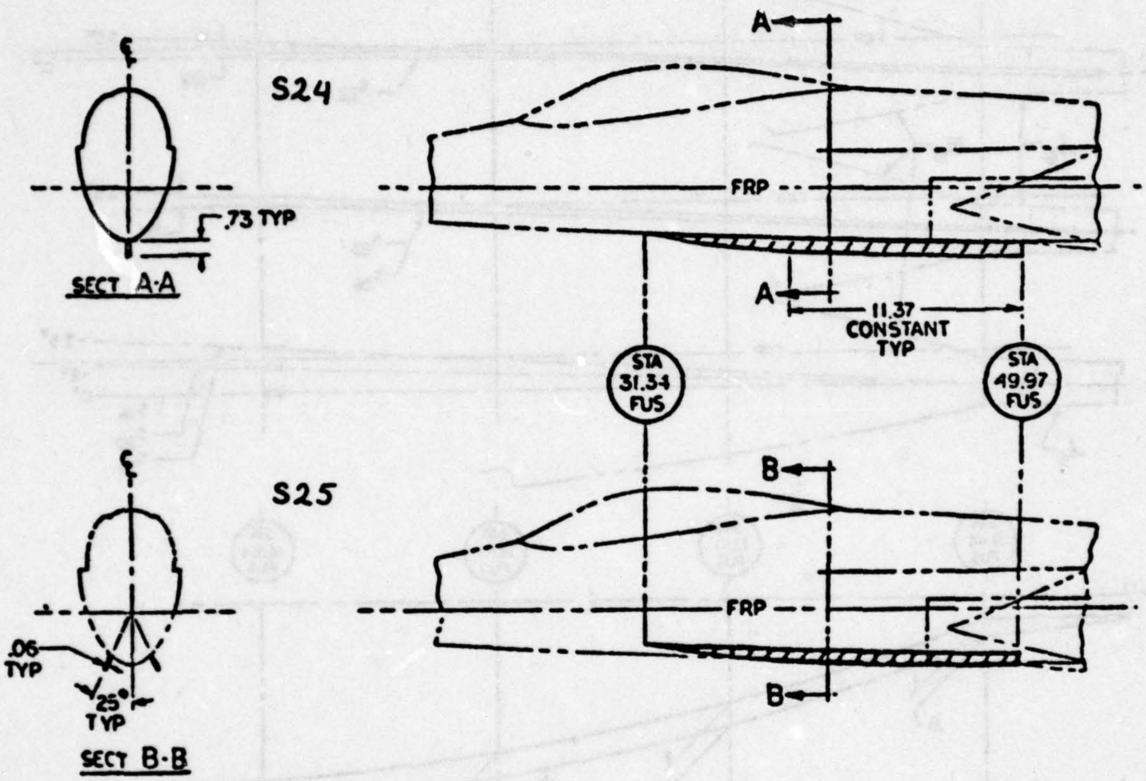


Figure 98. Body Strakes (S24, 25)

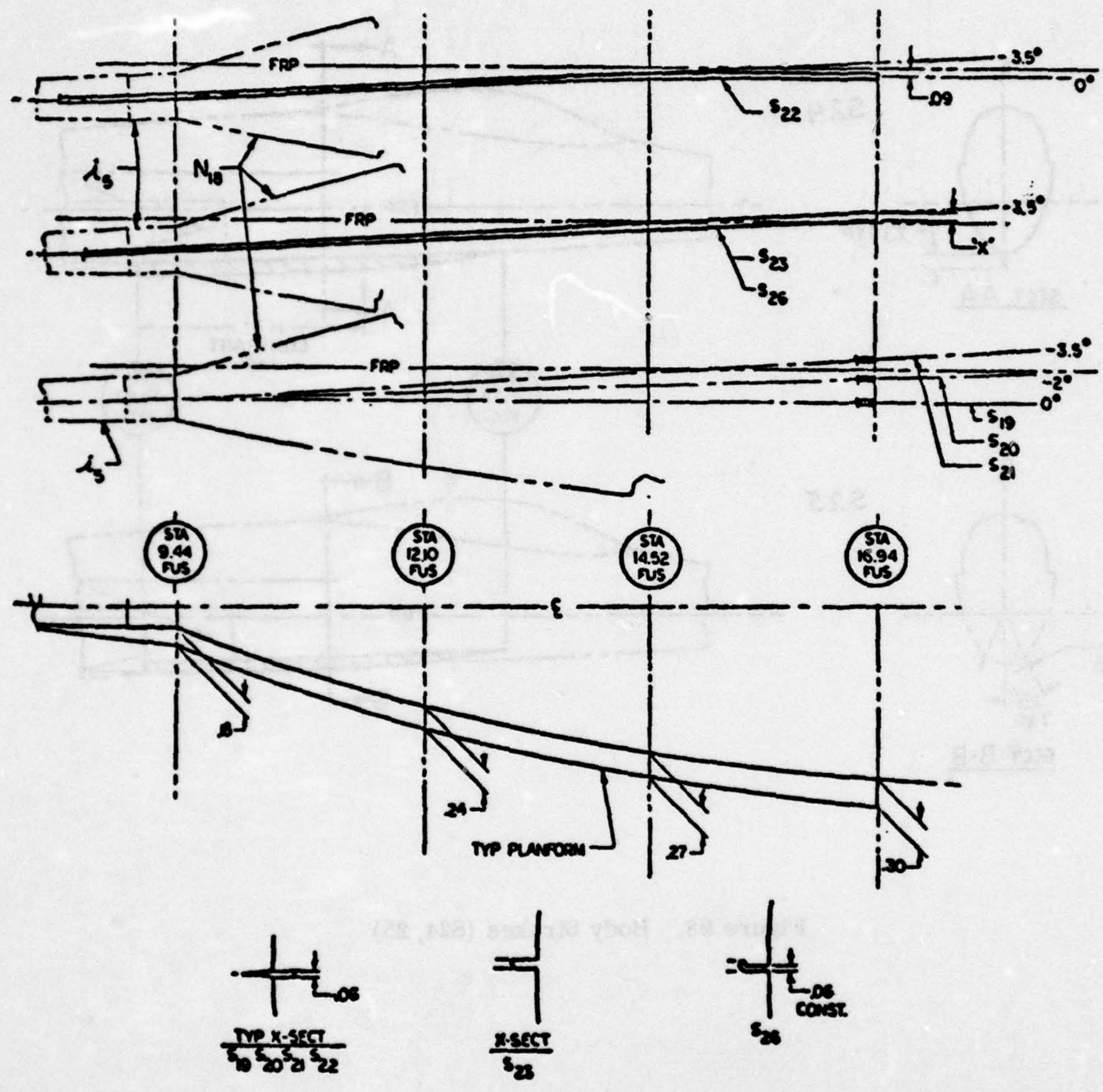


Figure 99. Nose Strake Angle Variation (S19, 20, 21, 22) and Nose Strake Cross-Section Variation (S19, 23, 26)

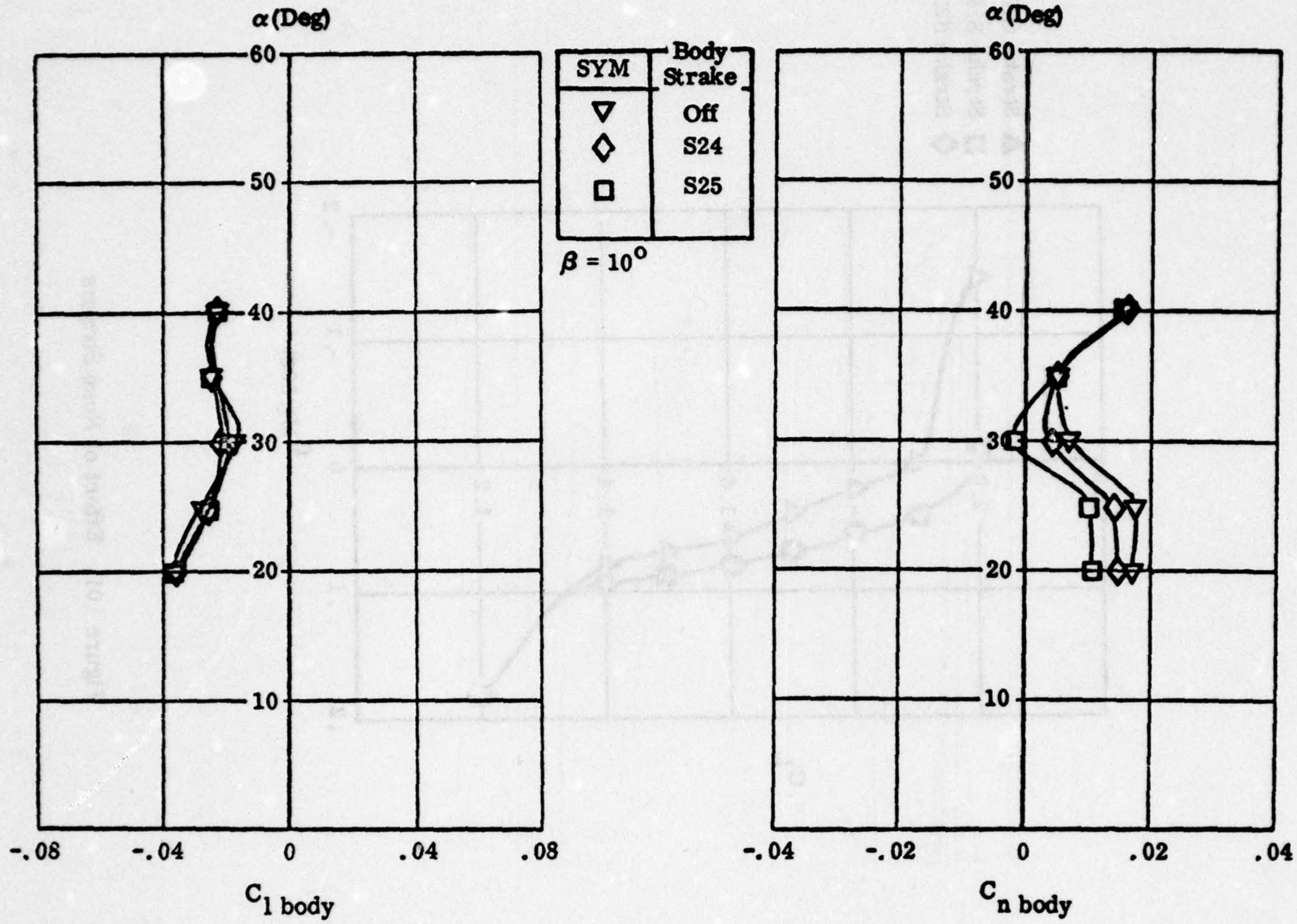


Figure 100. Effect of Body Strakes

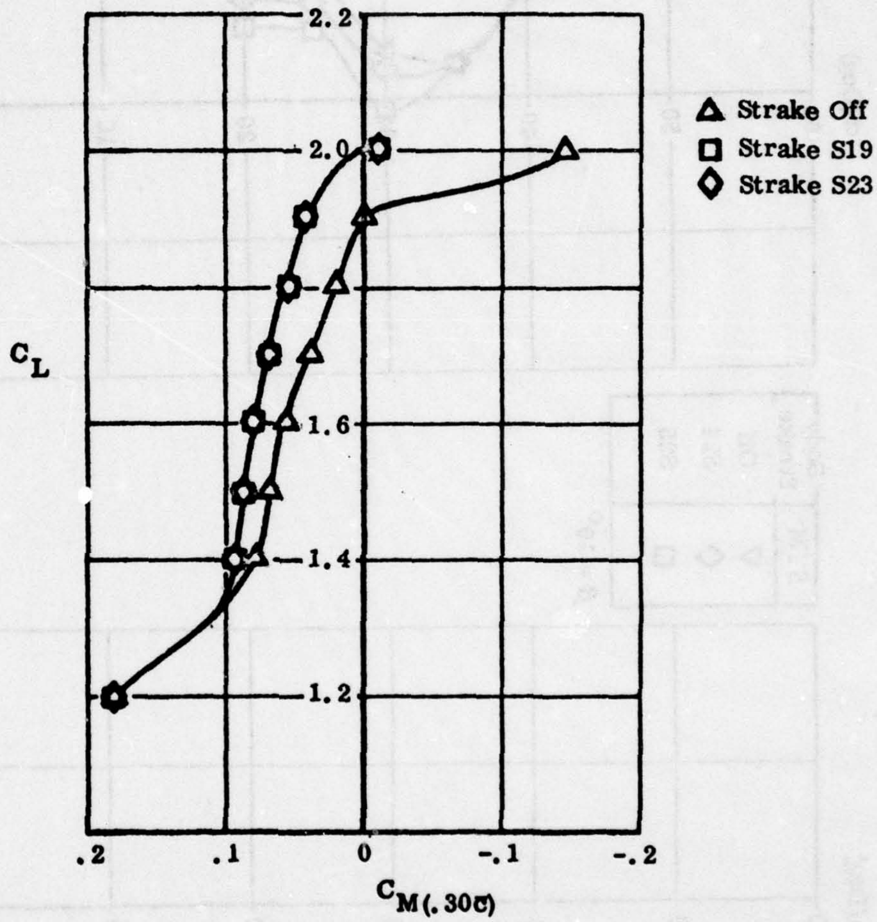


Figure 101. Effect of Nose Strakes

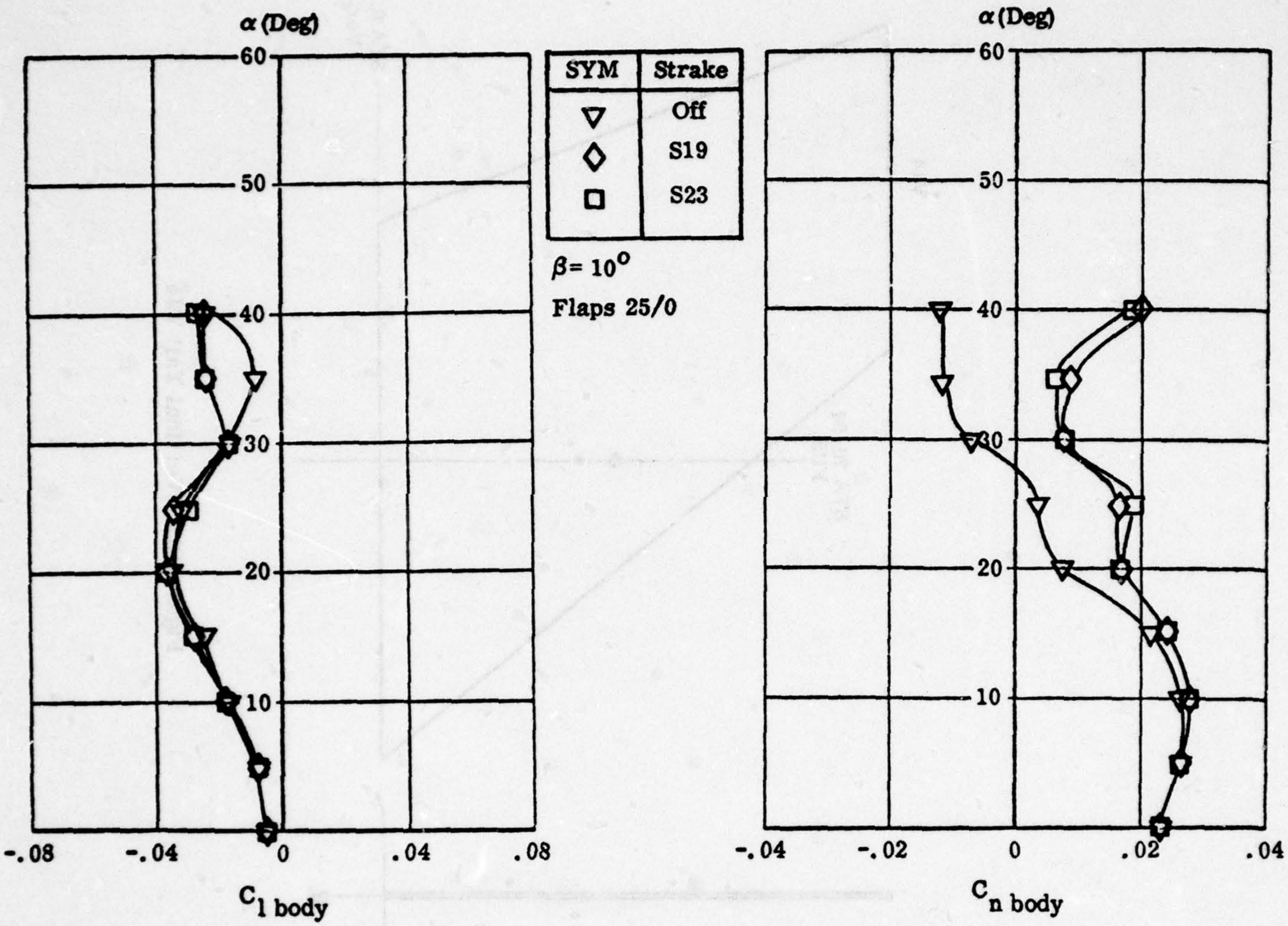


Figure 102. Effect of Nose Strakes

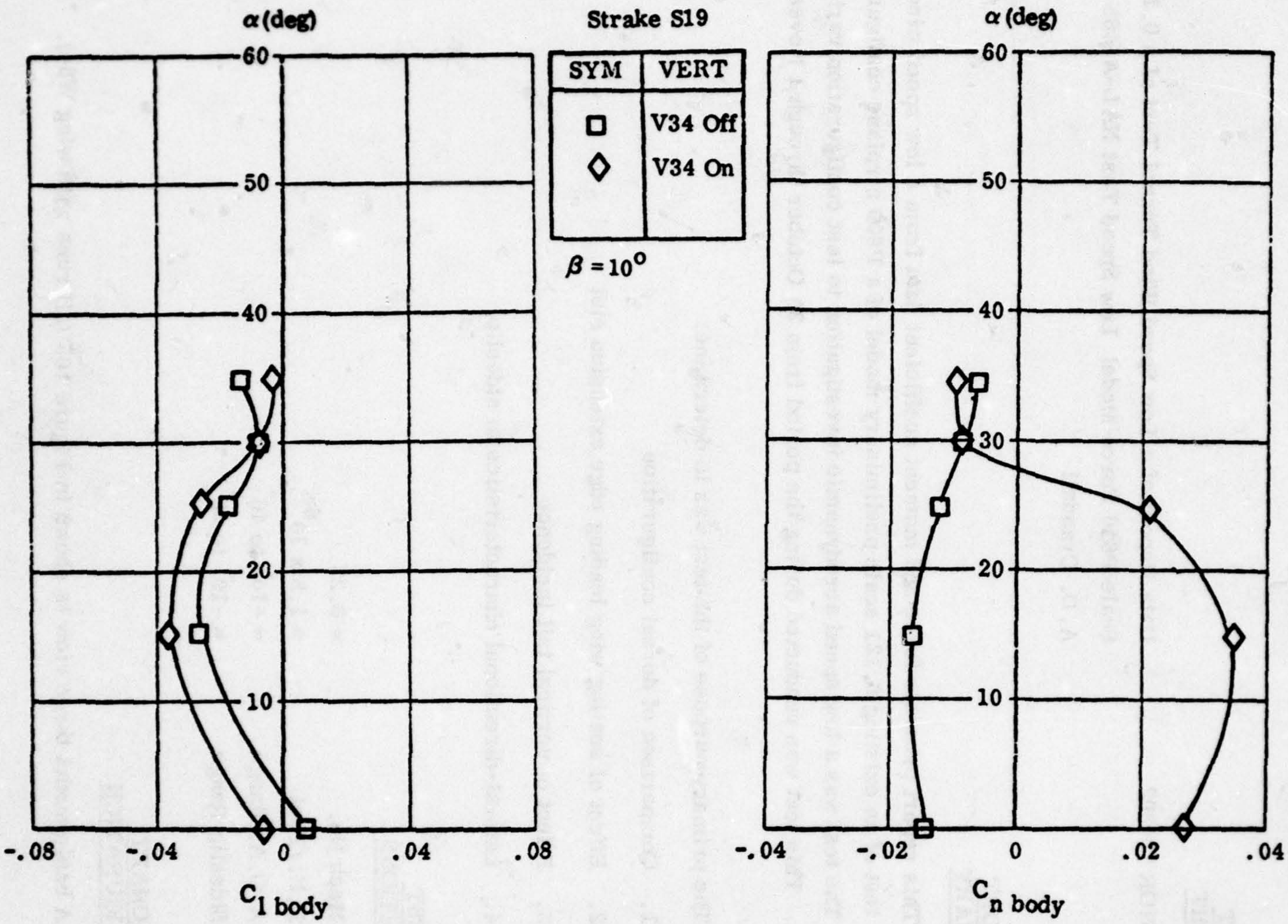


Figure 104. Effect of Single Vertical Tail V34

AIRCRAFT P600 **REFERENCE** 22

TEST REPORT

NOR 73-202 — Data Report of a Low Speed Wind Tunnel Test of a 0.121 Scale P600 Force Model Low Speed Test NAL-A-065
A.D. Crandall

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of an existing 0.121 scale preliminary model of a P600 airplane configuration. The test was a low speed aerodynamic investigation to test configuration variations. This test was conducted during the period from 30 October through 1 November 1973.

The primary purpose of the test was to determine:

1. Comparison of dorsal configuration
2. Effect of sealing wing leading edge extension slot
3. Effect of vertical tail incidence
4. Lateral-directional characteristics in sideslip

TEST CONDITIONS

Mach No.	= 0.22
R.N./Foot	= 1.5×10^6
A.O.A. Range	= -10° to 46°
Sideslip Range	= -10° to 20°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 105 (all runs with wing W54).

CONFIGURATION CHANGES

Sketches of the leading edge extension configuration changes applicable to this study are shown in Figure 106.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 107 shows the pitch effect of sealing the leading edge extension gutter, g19 and g20.

Data effects for objectives 1, 3 and 4 listed above were either insufficient or not considered pertinent.

DIMENSIONS ARE MODEL SCALE

Wing Area = 5.102 Ft^2

M.A.C. = 15.65 in

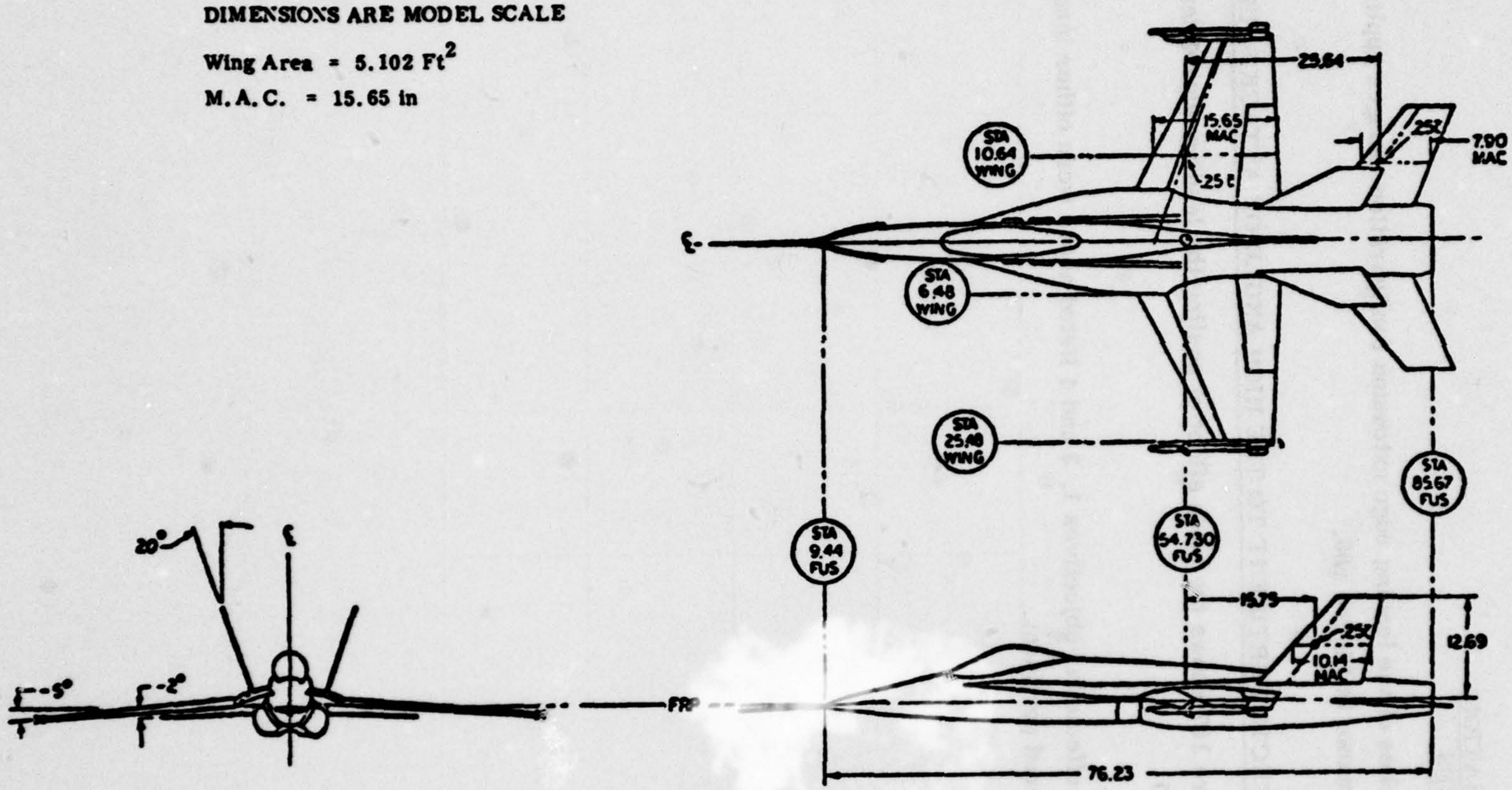


Figure 105. General Three View

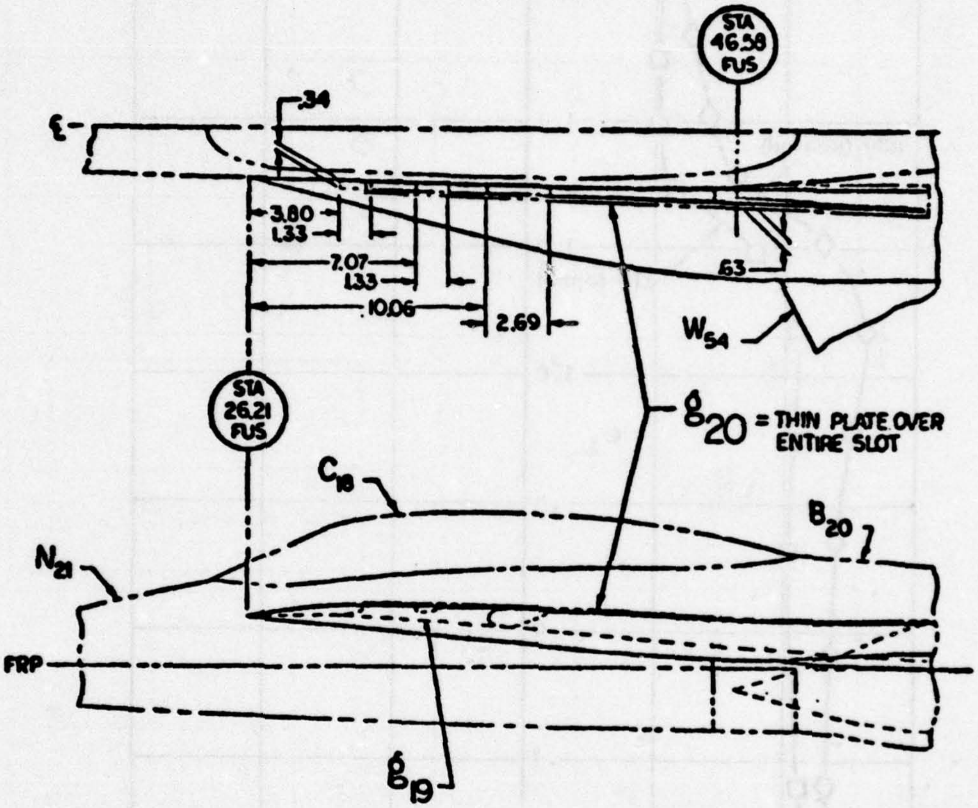


Figure 106. Sealing Lex Gutter (g19, 20)

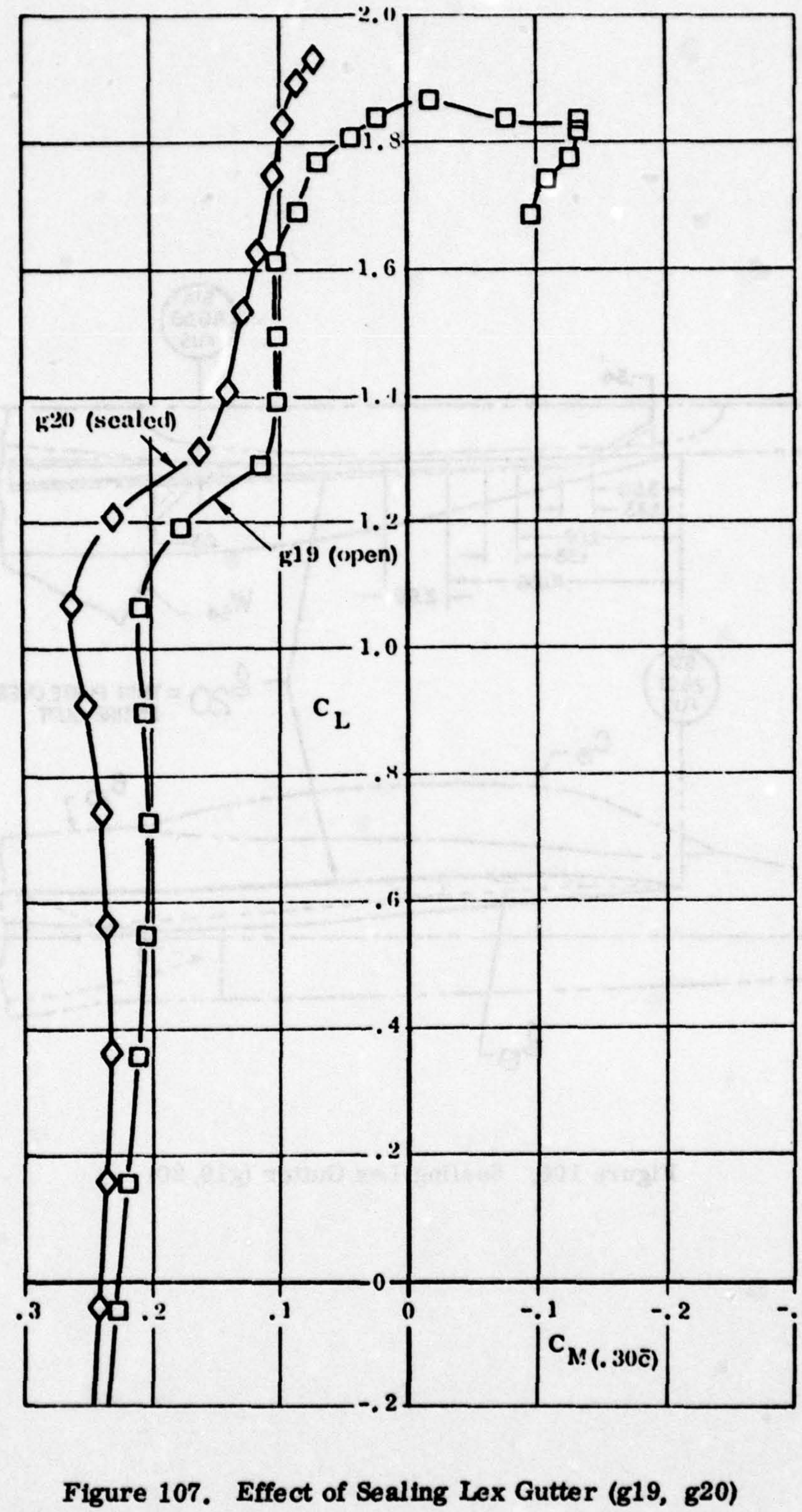


Figure 107. Effect of Sealing Lex Gutter (g19, g20)

SECTION V

P610 TEST DATA

Testing of the P610 configuration took place between September 1971 and February 1972, and was conducted mainly at Northrop, in the 7 x 10 foot low speed tunnel. A 0.1304 scale model was used. The basic wing configuration was with double drooped leading edge flaps, a LEX of approximately 15% wing area, and full span T. E. controls. Pertinent testing during this period was concerned with small changes in LEX area and cross section, and similar small changes in vertical area and cant angle.

AIRCRAFT P610 **REFERENCE** 23

TEST REPORT

NOR 72-034 — Data Report of a Low Speed Wind Tunnel Test of a 0.1304 Scale P610 Force Model First Low Speed Test (NAL-A-950)

A. D. Crandell — Volumes I and III

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a nominal 0.1304 scale model of a P610 airplane configuration. This test program was conducted during the period from 24 September to 5 October 1971.

The objectives of the test were to obtain:

1. Effect of Wing Leading Edge Extension Configurations
2. Effect of Wing Trailing Edge Flaps and Symmetrical Inboard Ailerons
3. Empennage Buildup
4. Horizontal Tail Effectiveness
5. Effect of Vertical Tail Area and Cant Angle
6. Outboard Aileron Effectiveness
7. Rudder Effectiveness
8. Effect of Wing Tip Launchers and Missiles
9. Lateral-Directional Characteristics in Sideslip
10. High Attitude Data

TEST CONDITIONS

Mach No. = 0.22
R. N./Foot = 1.5×10^6
A.O.A. Range = -6 to 40°
Sideslip Range = -10 to 25°

AIRCRAFT
CONDITIONS

A basic model three view is shown in Figure 108.

CONFIGURATION
CHANGES

Sketches of LEX planform and cross sectional shapes and vertical tail configuration changes applicable to this study are shown in Figures 109 and 115.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 110 and 111 show the effects on $C_{L_{MAX}}$ and lateral/directional stability of the following:

LEX planform, W3 through W5.

LEX cross-section, W2 through W4, W6, W7 and W9.

Flap setting was 40°/20°/0°.

Figure 112 shows the effect on $C_{L_{MAX}}$ of flap position with wing W2.

Figure 113 shows pitching moment due to sideslip for wing W2 with a flap setting of 40° /20° /10° and Figure 114 shows the lateral/directional characteristics at zero sideslip for wing W2 and a flap setting of 40° /20° /0°.

Figure 116 shows the effect on lateral/directional stability of vertical tail cant angle V1 and V2.

Data effects for objectives 3, 4 and 6 through 8 listed above was either insufficient or not considered pertinent.

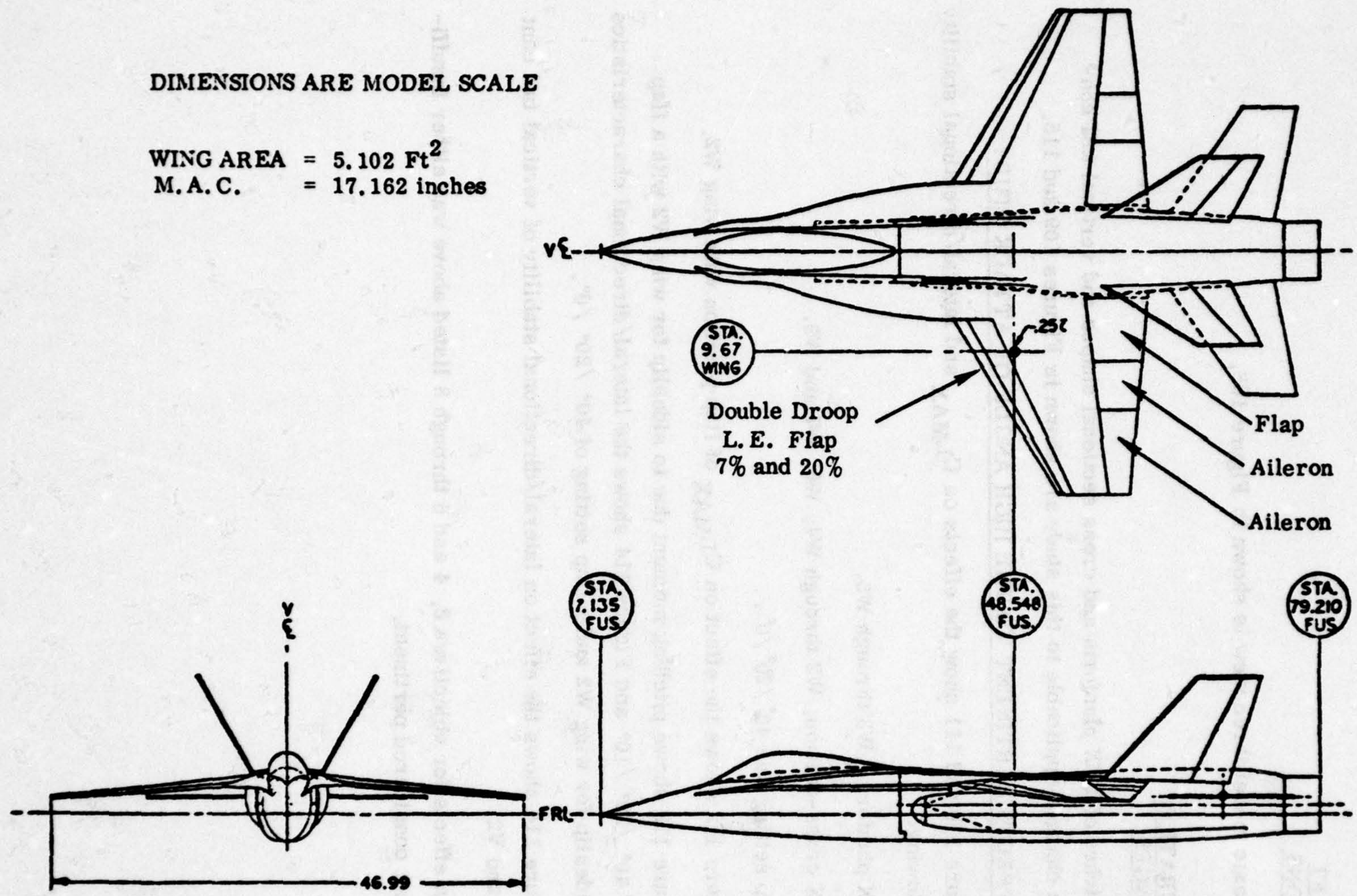
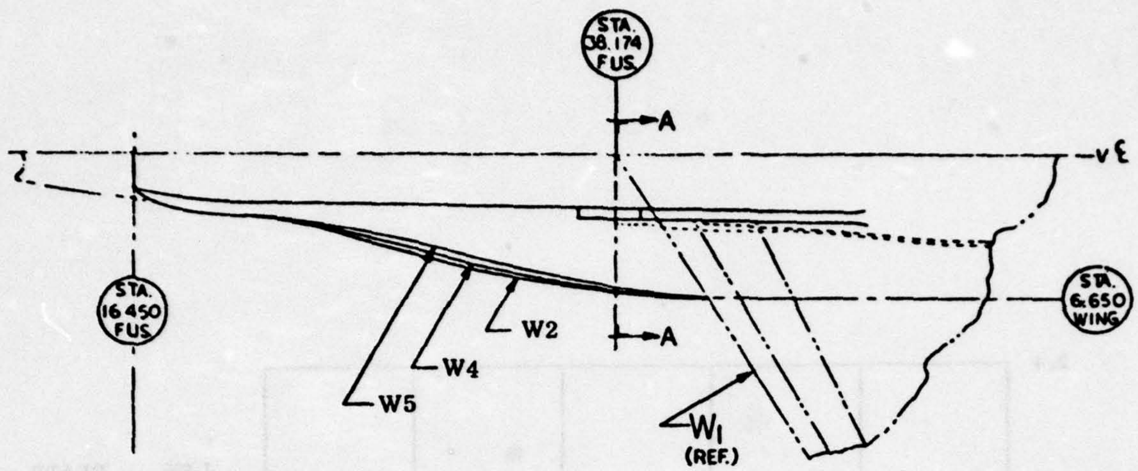


Figure 108. General Three View



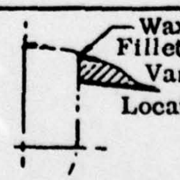
WING	PLANFORM	SECTION A-A	S_L/S_W
W2	W2		0.145
W3 W4 W5	W2 W4 W5		0.145 0.137 0.131
W6	W4		0.137
W7 W8 W9	W4 W4 W4		0.137

Figure 109. Lex Planform and Cross Sectional Shapes

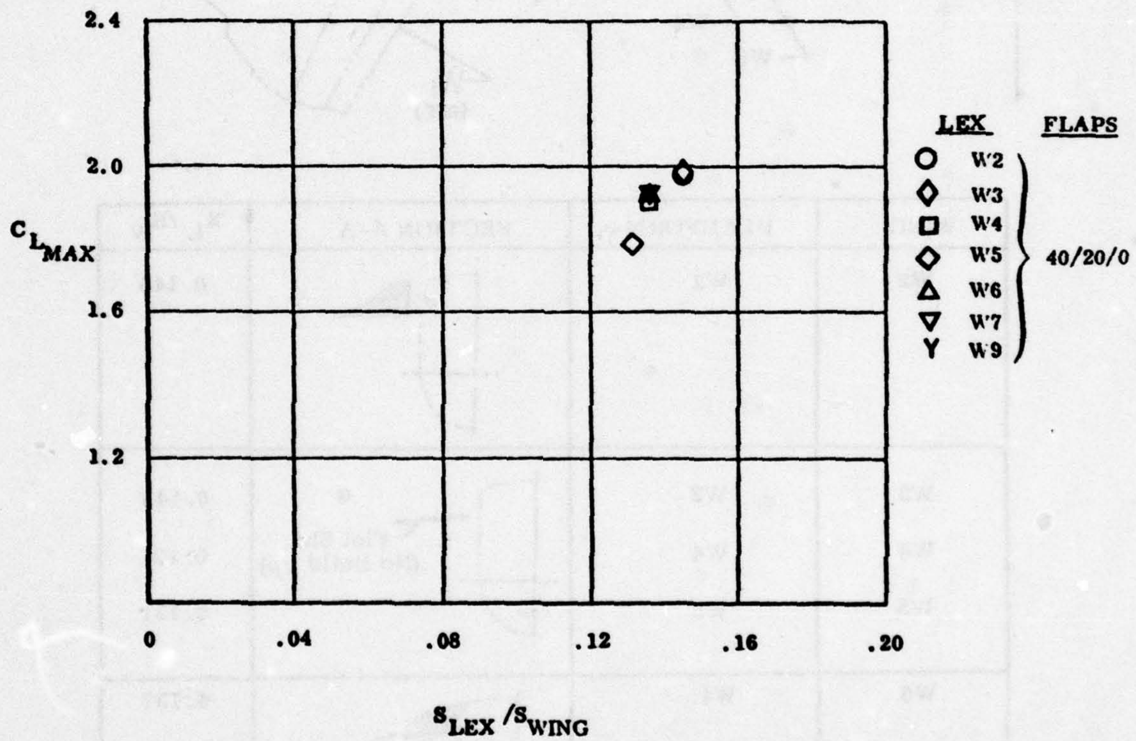
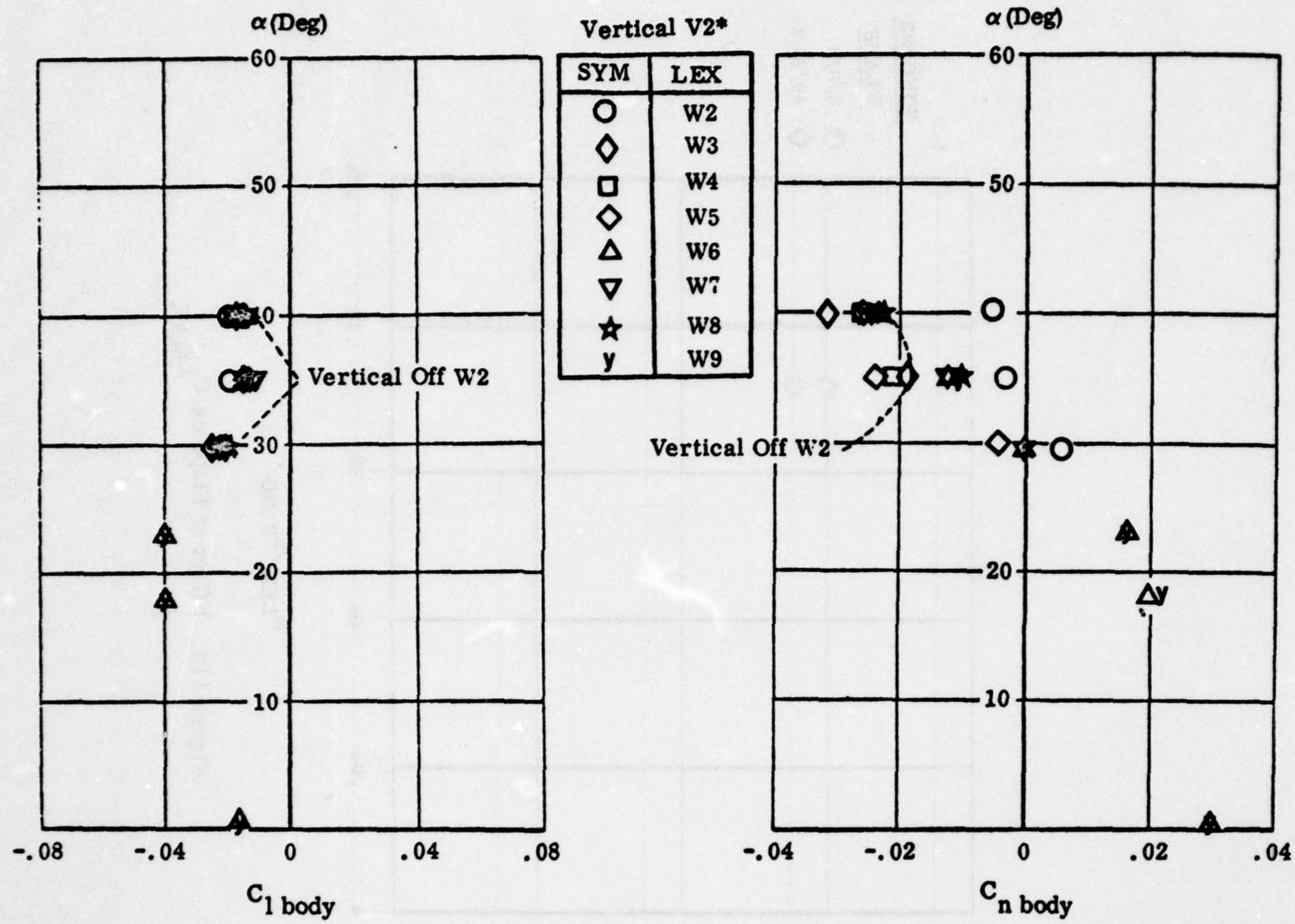


Figure 110. Effect of Lex Variation on $C_{L_{MAX}}$



*Vertical V2 - See Figure

Figure 111. Effect of Lex Variation

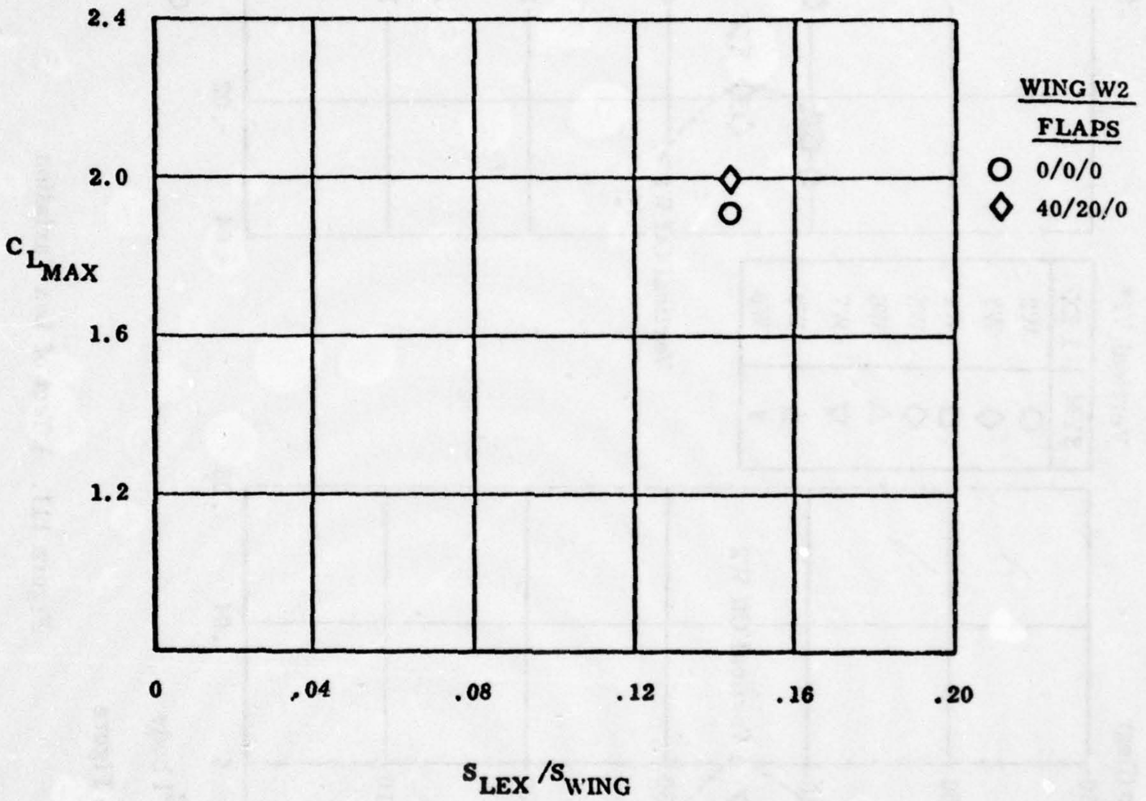


Figure 112. Effect of Flaps on $C_{L_{MAX}}$

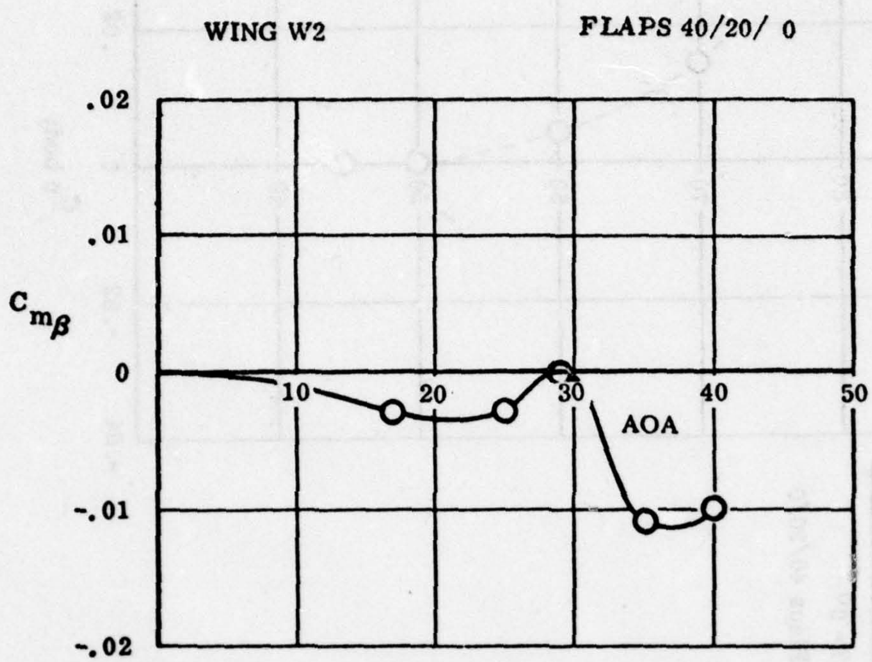


Figure 113. Pitching Moment Due to Sideslip

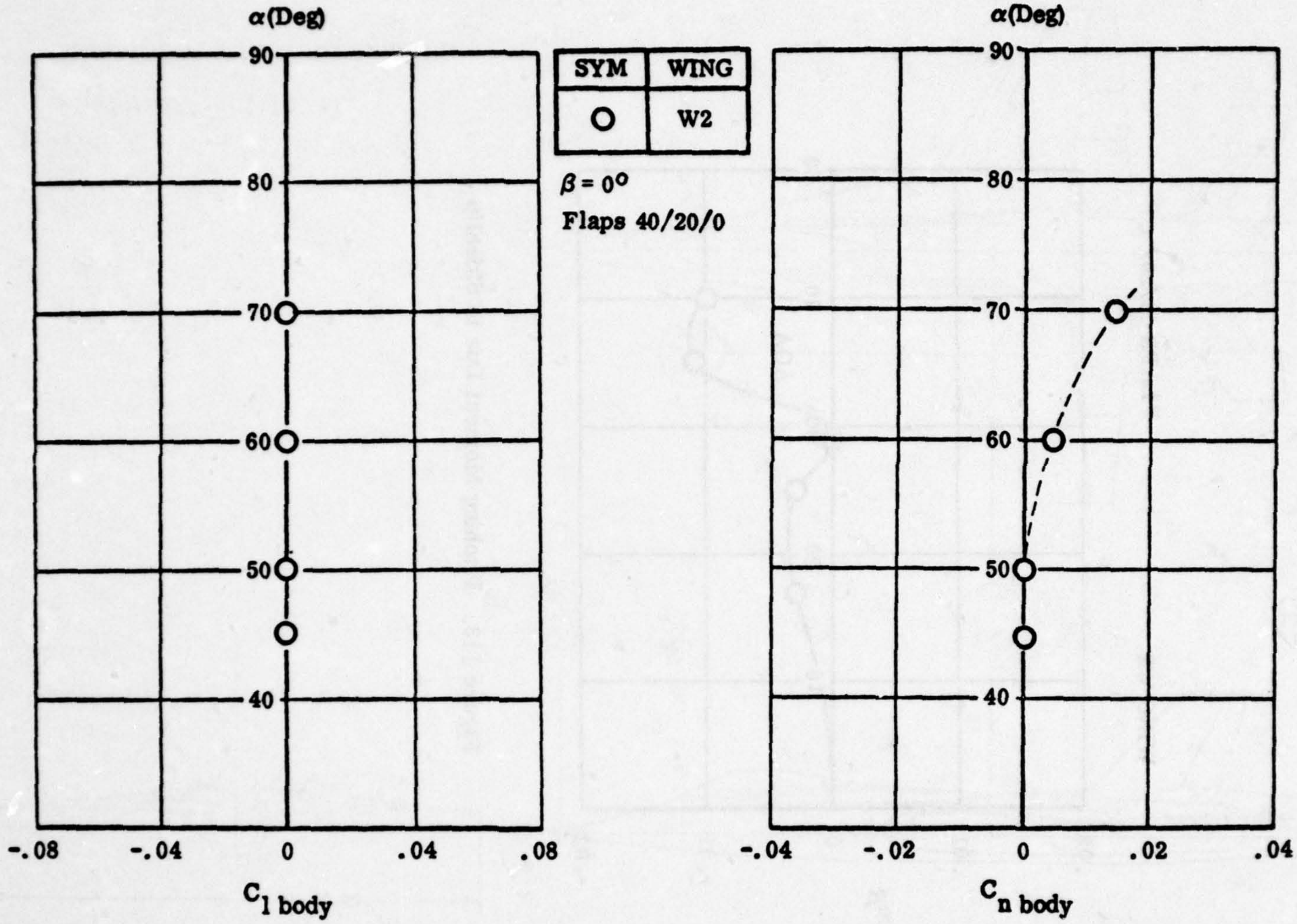
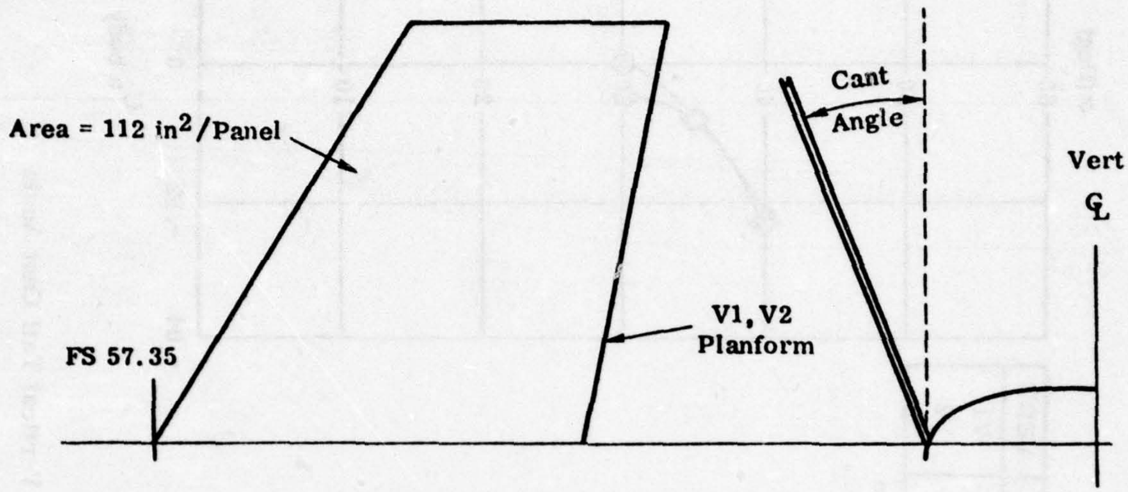


Figure 114. Zero Sideslip Effects



VERTICAL	CANT ANGLE
V1	30°
V2	25°

Figure 115. Vertical Tail Configurations

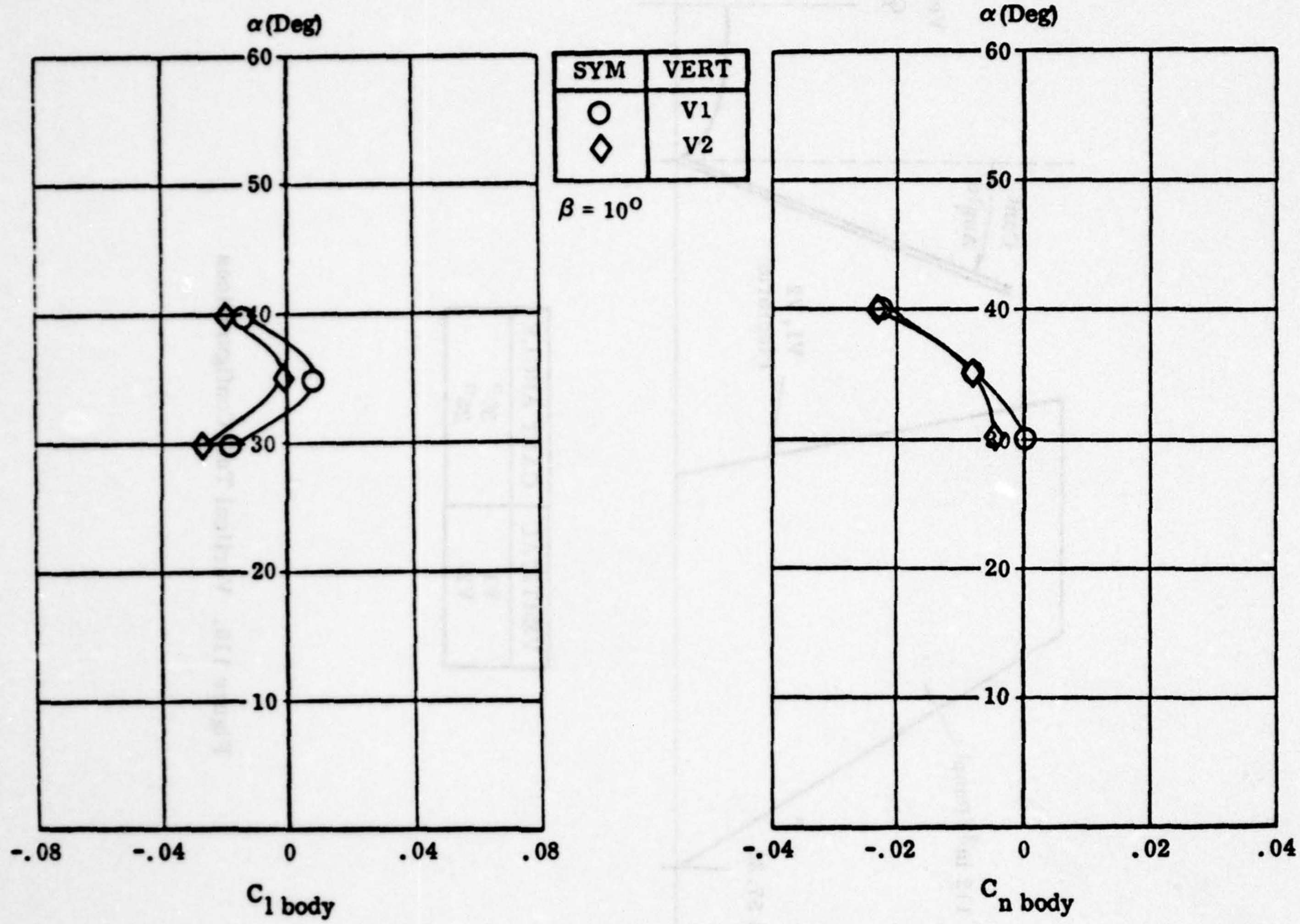


Figure 116. Effect of Vertical Tail Cant Angle

AIRCRAFT $\boxed{\text{P610}}$ **REFERENCE** $\boxed{24}$

TEST REPORT

NOR-72-050	Data Report of a Low Speed Wind Tunnel Test of a 0.1304 Scale P610 Force Model Second Low Speed Test (NAL-A-954) A. D. Crandell

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a nominal 0.1304 scale model of a P610 airplane configuration. This test program was conducted during the period from 27 through 29 October 1971.

The objectives of the test were to obtain:

1. Effect of Wing Trailing Flaps and Symmetrical Inboard Ailerons
2. Effect of Horizontal Tail Area
3. Horizontal Tail Effectiveness
4. Effect of Wing Tip Launchers and Missiles
5. Hi-Attitude Investigation

TEST CONDITIONS

Mach No.	= 0.22
R. N/Foot	= 1.5×10^6
A.O.A. Range	= -6° to 40° (Basic)
Sideslip Range	= -10° to 25° (Basic)

AIRCRAFT CONFIGURATIONS

The basic model three view is identical to that shown in Figure 108.

CONFIGURATION CHANGES

A sketch of wing W2, applicable to this test, is shown in Figure 109.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 117 shows $C_{L_{MAX}}$ for wing W2 with flaps 40° /20° /0°.

Data effects for objectives 2 through 4 listed above was either insufficient or not considered pertinent.

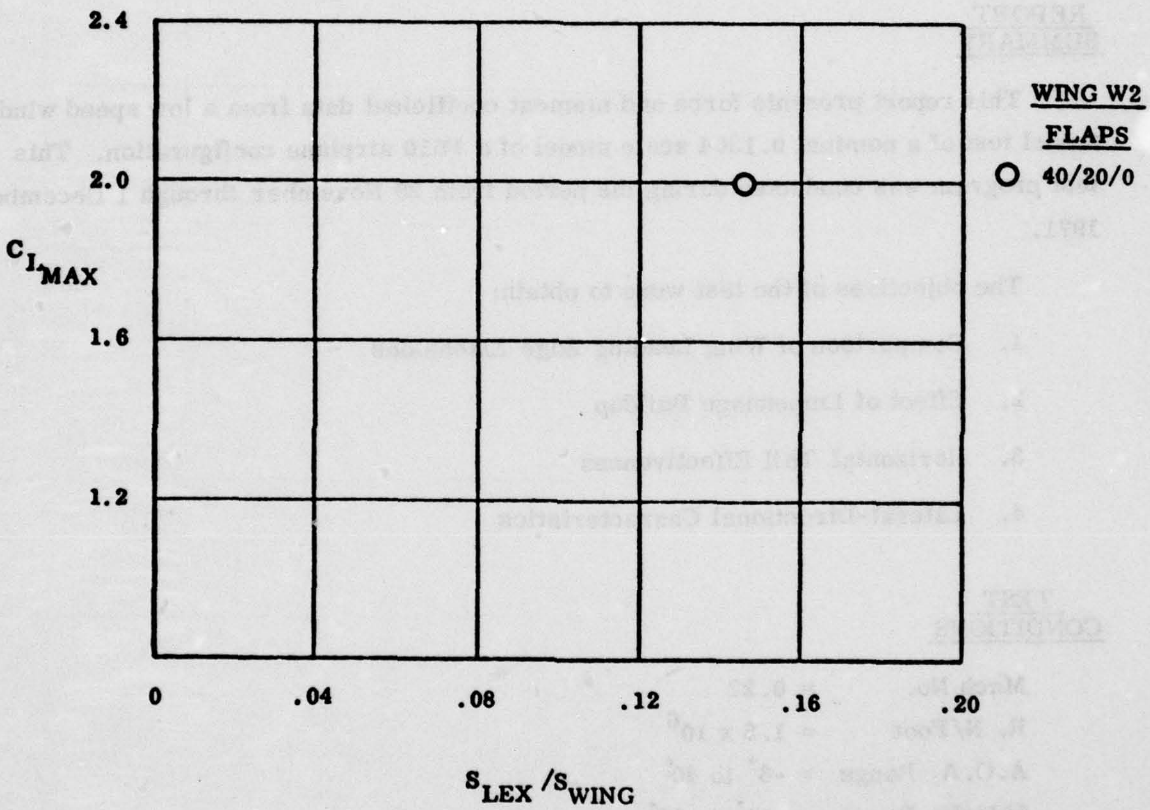


Figure 117. $C_{L_{MAX}}$ with Wing W2 and Flaps

AIRCRAFT | P610 | REFERENCE | 25

TEST REPORT

NOR 72-061 — Data Report of a Low Speed Wind Tunnel Test of a 0.1304 Scale P610 Force Model Third Low Speed Test (NAL-A-960)
A. D. Crandell

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a nominal 0.1304 scale model of a P610 airplane configuration. This test program was conducted during the period from 29 November through 1 December 1971.

The objectives of the test were to obtain:

1. Comparison of Wing Leading Edge Extensions
2. Effect of Empennage Buildup
3. Horizontal Tail Effectiveness
4. Lateral-Directional Characteristics

TEST CONDITIONS

Mach No. = 0.22
R. N/Foot = 1.5×10^6
A.O.A. Range = -6° to 40°
Sideslip Range = -10° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 110.

CONFIGURATION CHANGES

Sketches of LEX cross-section and vertical tail configuration changes applicable to this study are shown in Figures 109 and 122.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 120 shows the effect on $C_{L_{MAX}}$ of LEX cross-sections W2, W12 and W15 and the effect of flap deflection, 0/0/0 to 40°/20°/0°.

Figure 121 shows the effect on the $C_L - C_m$ curve of LEX cross-sections W2, W12 and W15.

Figure 123 shows the effect on lateral/directional stability of vertical tail cant angle V2 and V7 with wing W12 and flaps 40°/20°/0°.

Data effects for objectives 2 and 3 listed above was either insufficient or not considered pertinent.

DIMENSIONS ARE MODEL SCALE

WING AREA = 5.102 Ft^2

M.A.C. = 17.162 inches

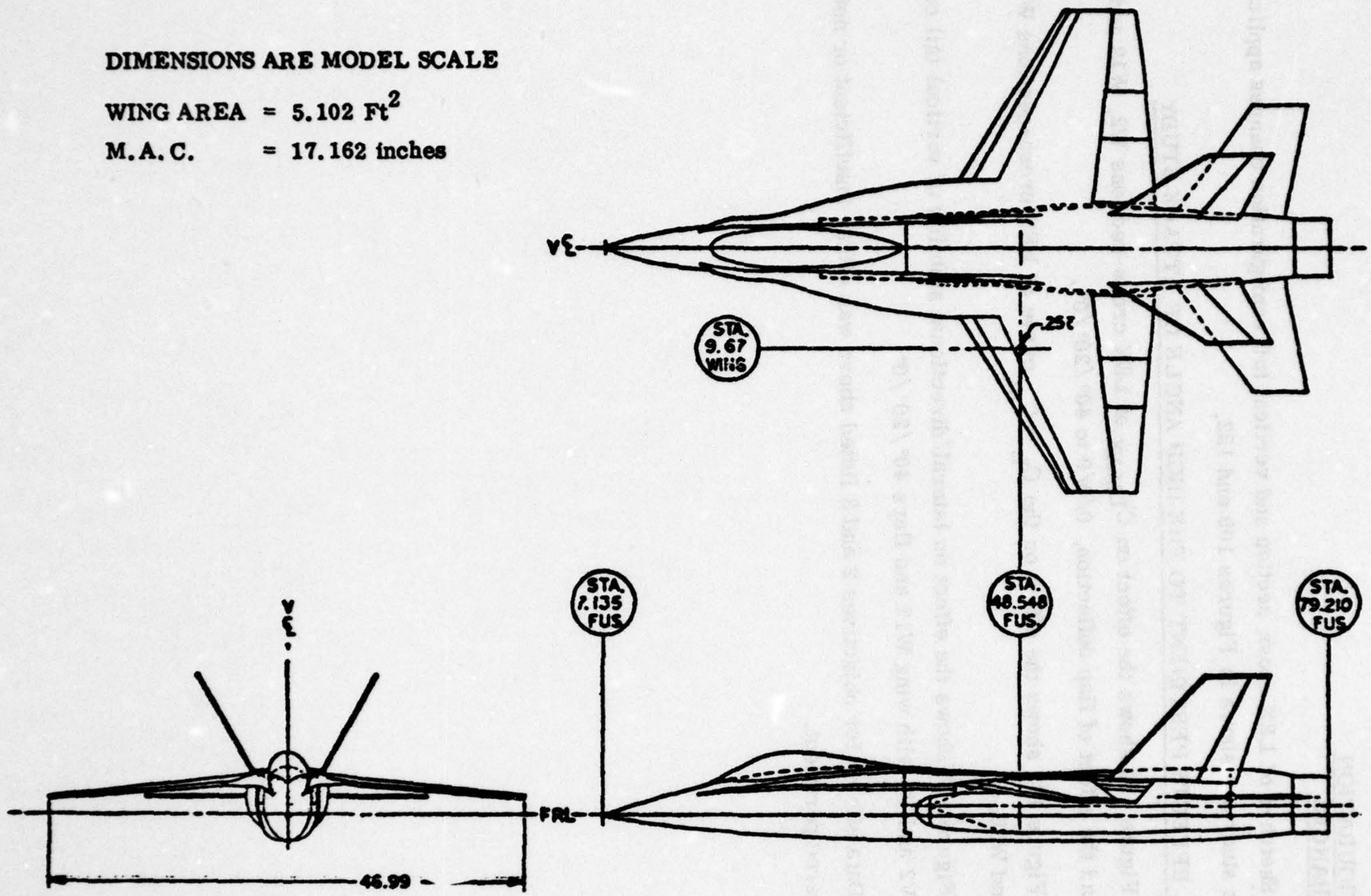
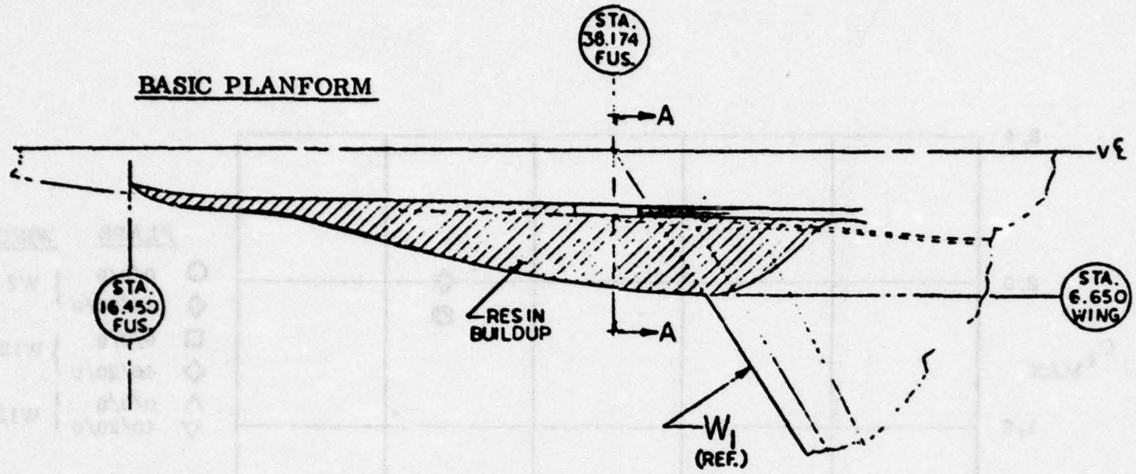


Figure 118. General Three View

BASIC PLANFORM



ALL WINGS $S_L / S_W = 0.145$

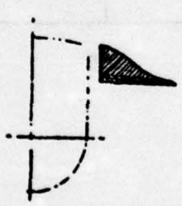
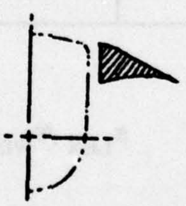
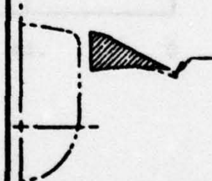
LEX	W2	W12	W15
SECTION A-A			

Figure 119. Variation in Lex Cross Section

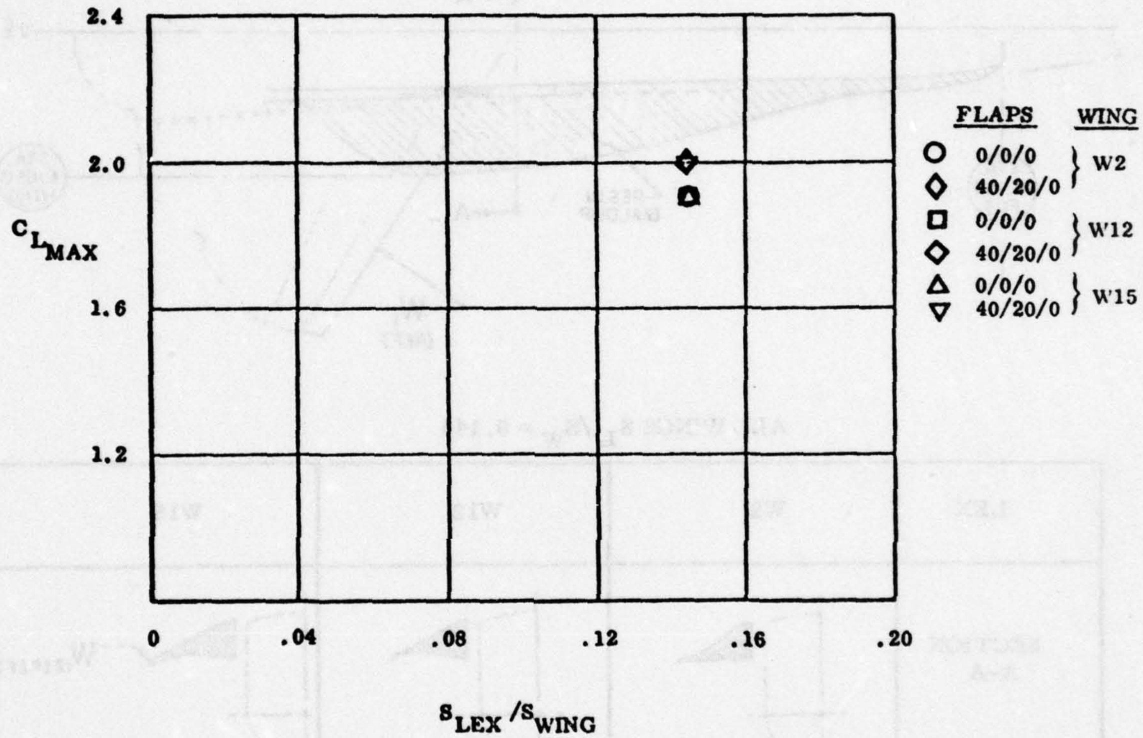


Figure 120. Effect of Lex Cross Section and Effect of Flaps on $C_{L_{MAX}}$

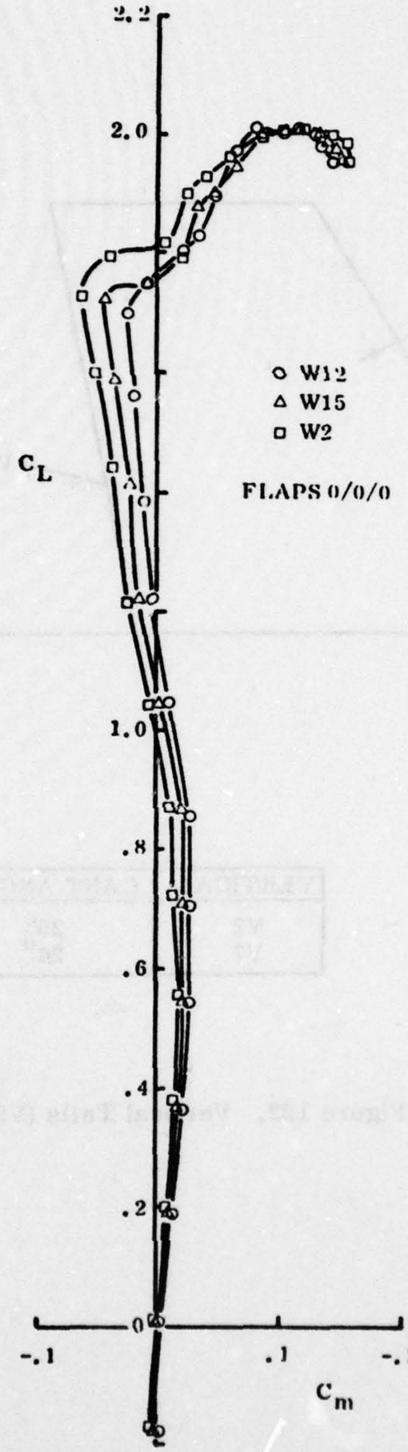


Figure 121. Effect of Lex Cross Section on $C_L - C_m$ Curve

AD-A069 647 NORTHROP CORP HAWTHORNE CA AIRCRAFT GROUP F/G 20/4
ANALYSIS OF WIND TUNNEL DATA PERTAINING TO HIGH ANGLE OF ATTACK--ETC(U)
JUL 78 J W HEADLEY F33615-77-C-3062
UNCLASSIFIED NOR-78-69-VOL-2 AFFDL-TR-78-94-VOL-2 NL

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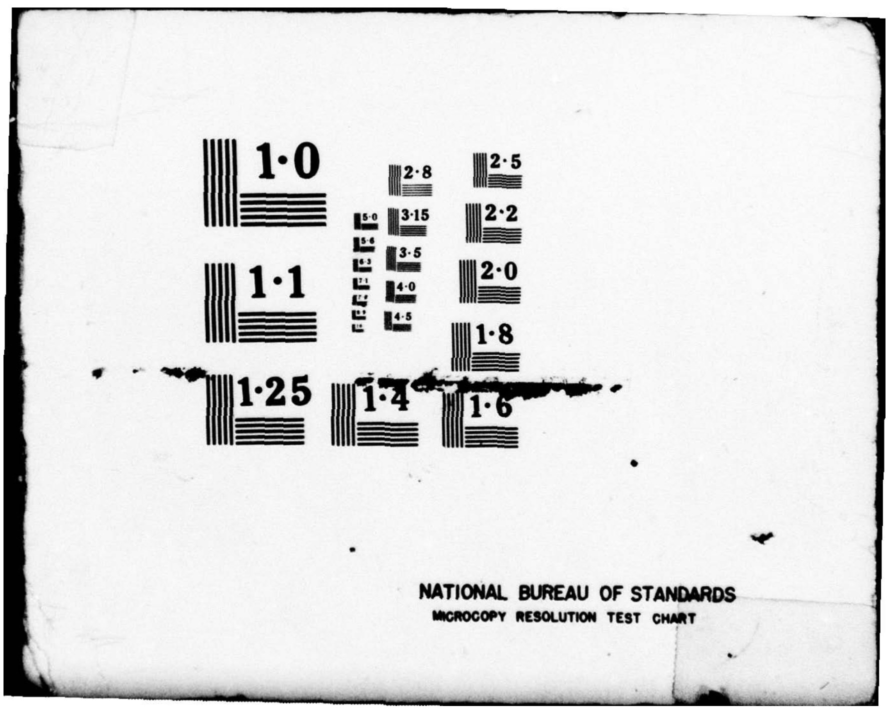
1·0
2·8
2·5
3·15
2·2
5·0
5·6
3·5
1·1
2·0
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4·5
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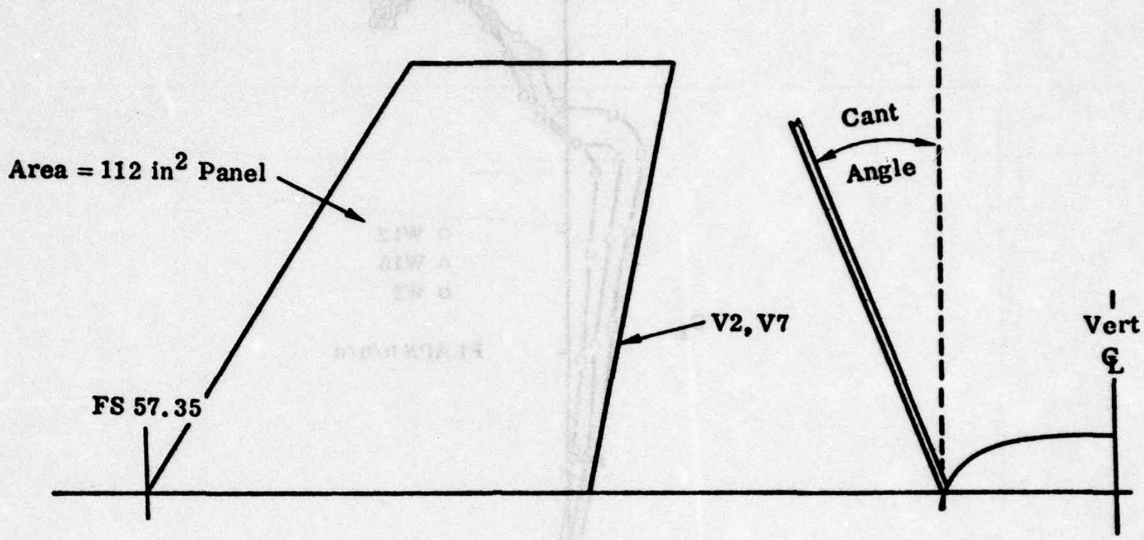
1·25
1·4
1·6
NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART



VERTICAL	CANT ANGLE
V2	25°
V7	20°

Figure 122. Vertical Tails (V2, V7)

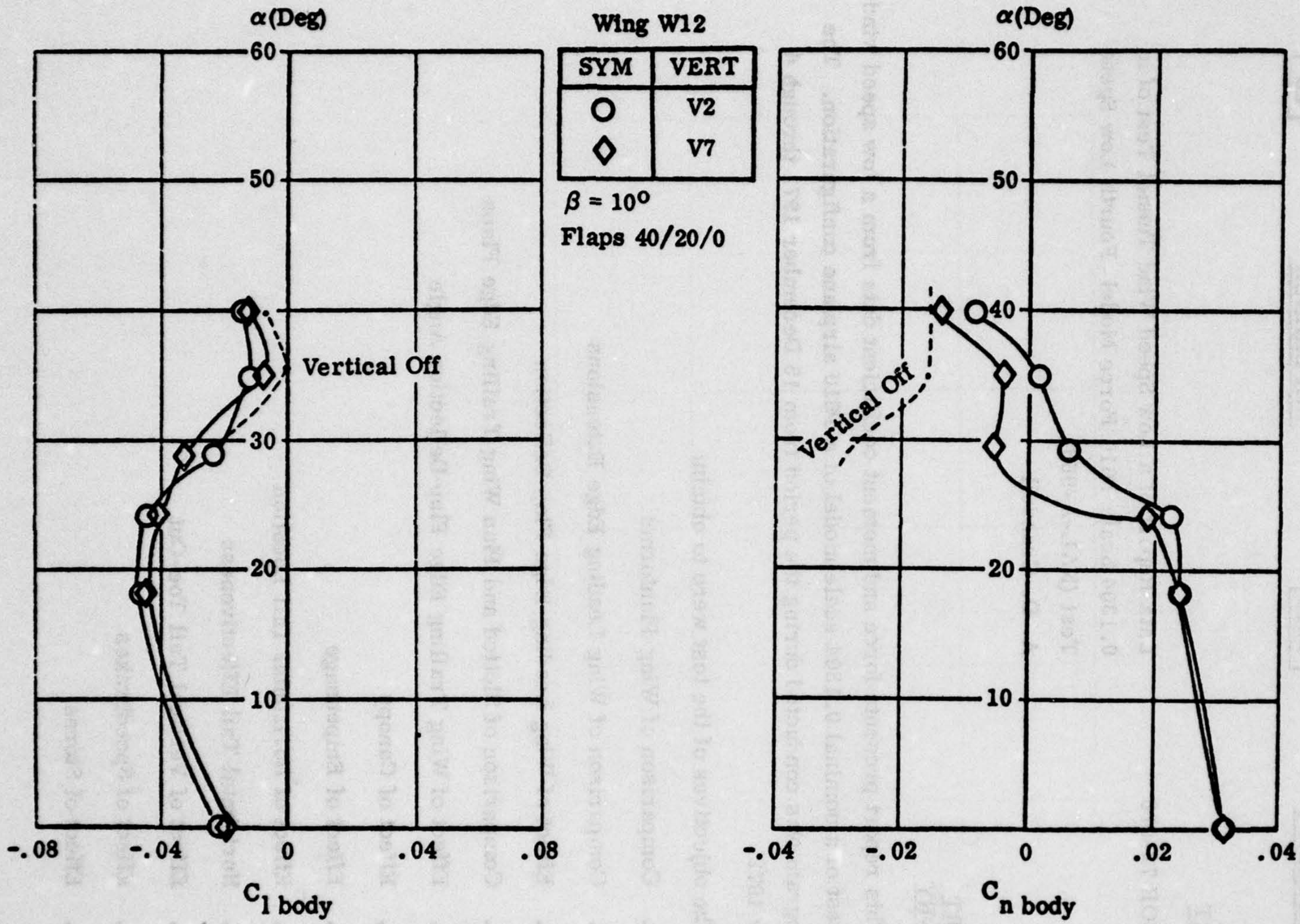


Figure 123. Effect of Vertical Tail Cant Angle

AIRCRAFT **P610** REFERENCE **26**

TEST REPORT

NOR 72-070 — Data Report of a Low Speed Wind Tunnel Test of a 0.1304 Scale P610 Force Model Fourth Low Speed Test (NAL-A-963)

A. D. Crandell

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a nominal 0.1304 scale model of a P610 airplane configuration. The test program was conducted during the period from 15 December 1971 through 4 January 1972.

The objectives of the test were to obtain:

1. Comparison of Wing Planforms
2. Comparison of Wing Leading Edge Extensions
3. Effect of Wing Leading Edge Flap Deflection
4. Comparison of Slotted and Plan Wing Trailing Edge Flaps
5. Effect of Wing Trailing Edge Flap Deflection Angle
6. Effect of Canopy
7. Effect of Empennage
8. Effect of Horizontal Tail Location
9. Horizontal Tail Effectiveness
10. Effect of Vertical Tail Toe-Out
11. Effect of Speedbrakes
12. Effect of Stores

TEST CONDITIONS

MACH NO. = 0.22

R. N./Foot = 1.5×10^6

A.O.A. Range = -6° to 40°

Sideslip Range = -10° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 124.

CONFIGURATION CHANGES

Sketches of LEX planforms, LEX cross-sections, wing aspect ratio and vertical tail configuration changes applicable to this study are shown in Figures 129 and 131.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 127 shows the effect on $C_{L_{MAX}}$ of LEX cross-section W2, W12, W16 and W21 with a wing flap deflection of 40°/20°/0°.

Figure 128 shows the effect of LEX planform W2 and W21 on the rolling moment due to sideslip at various angles of attack.

Figure 130 shows the effect of $C_{L_{MAX}}$ of wing aspect ratio, W2 and W20 for a flap deflection of 40°/20°/0°.

Figure 132 shows the effect on lateral/directional stability of vertical tail toe-out angle, V2, V10 and V11 with wing W2 and flaps deflected 40°/20°/0°.

Data effects for objectives 3 through 9, 11 and 12 listed above were either insufficient or not considered pertinent.

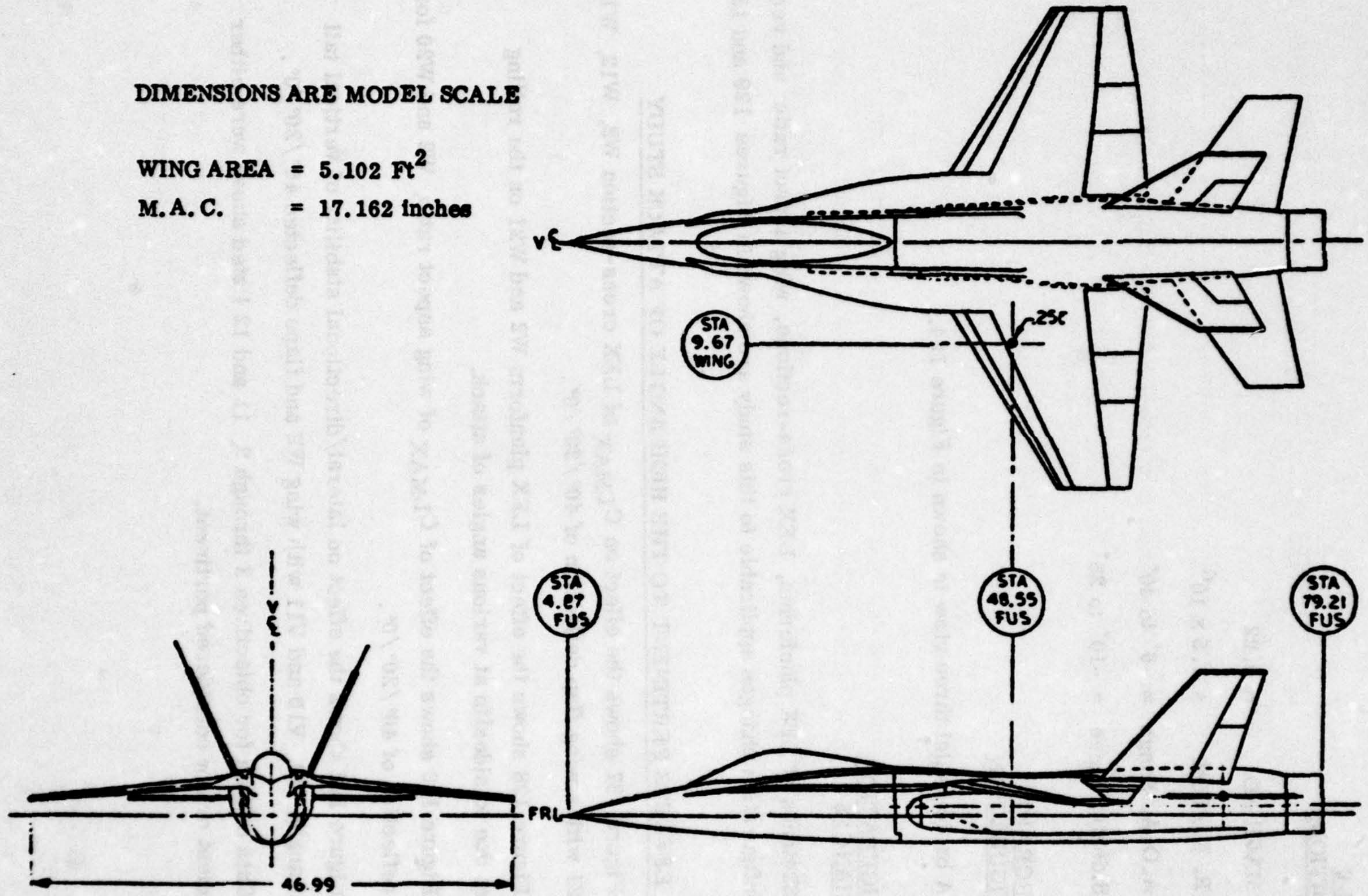


Figure. 124. General Three View

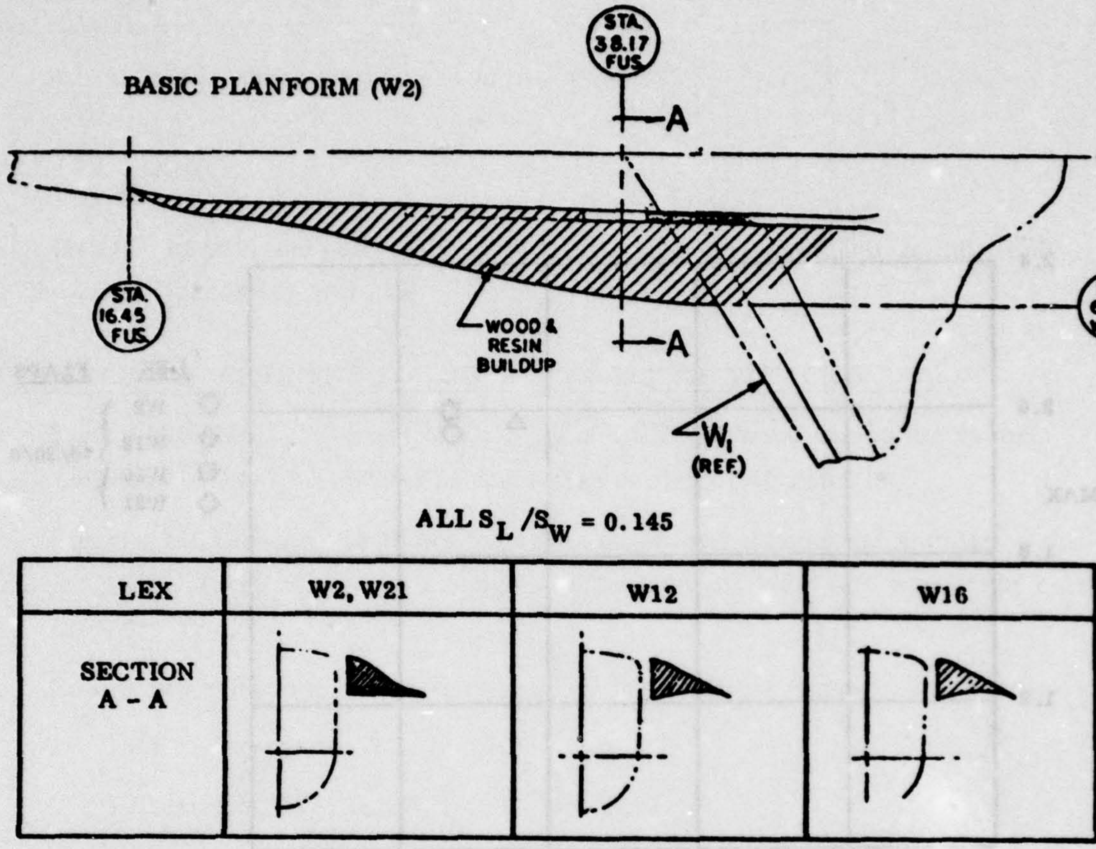


Figure 125. Lex Cross Section Variation

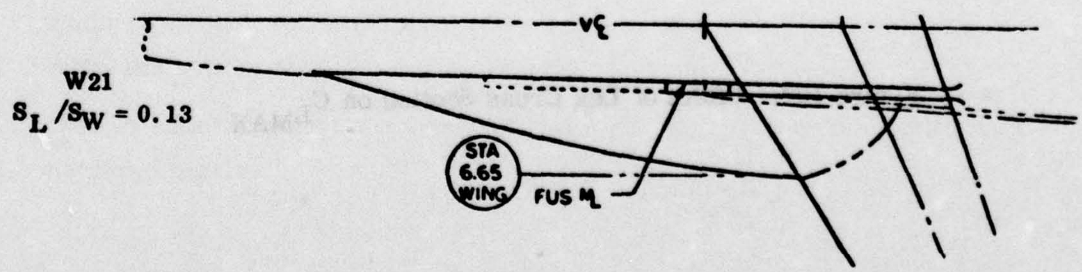


Figure 126. Lex W21

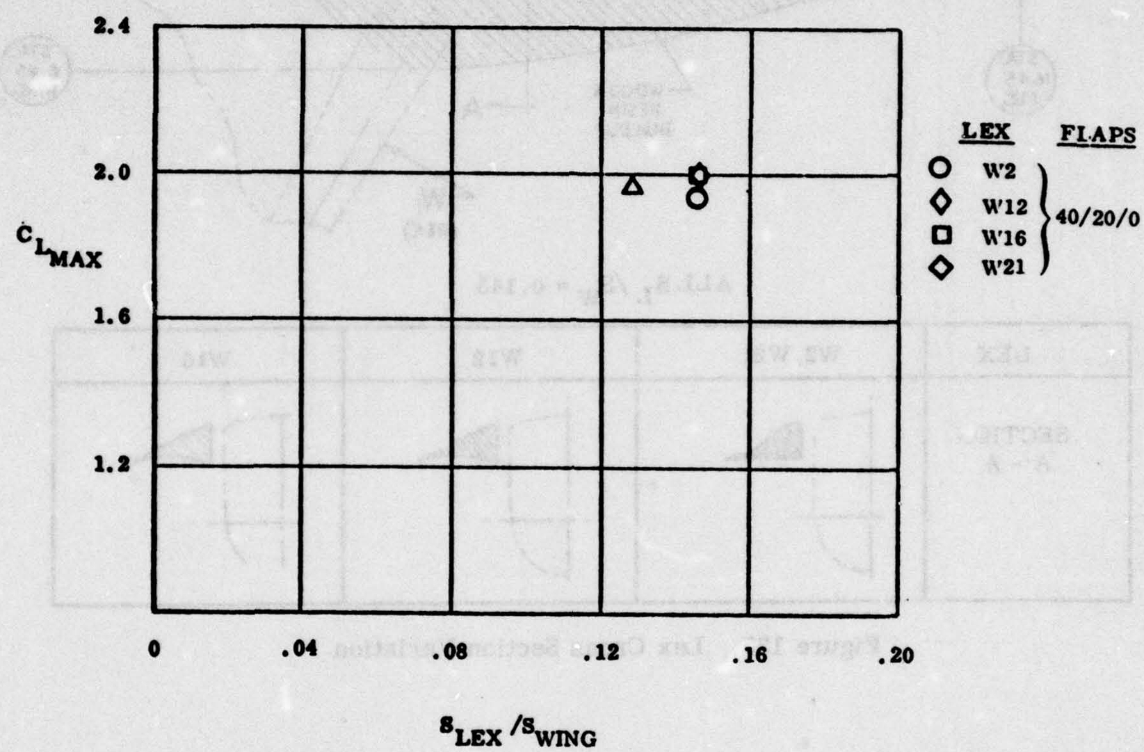


Figure 127. Effect of Lex Cross Section on $C_{L_{MAX}}$

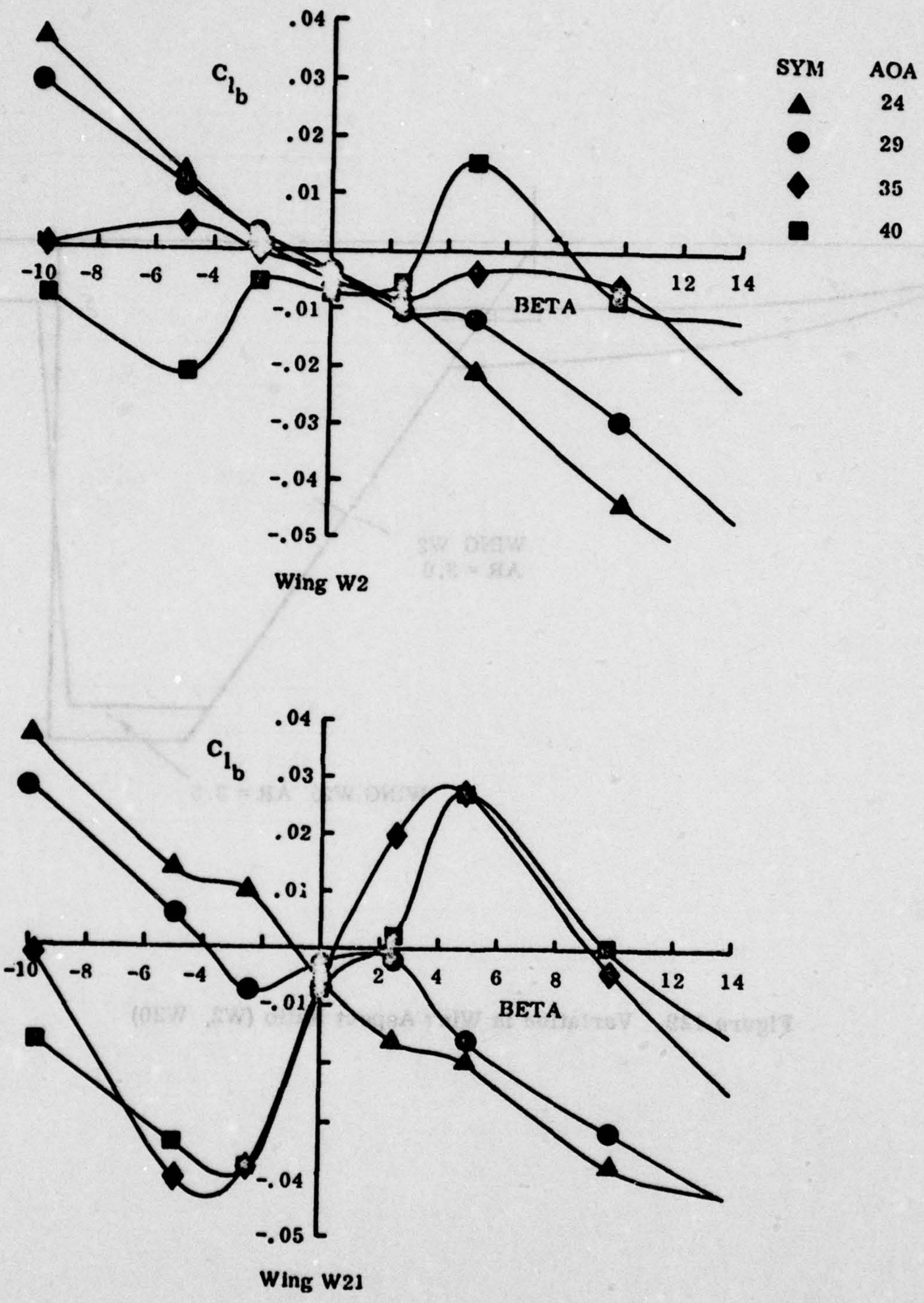


Figure 128. Effect of Lex Planform

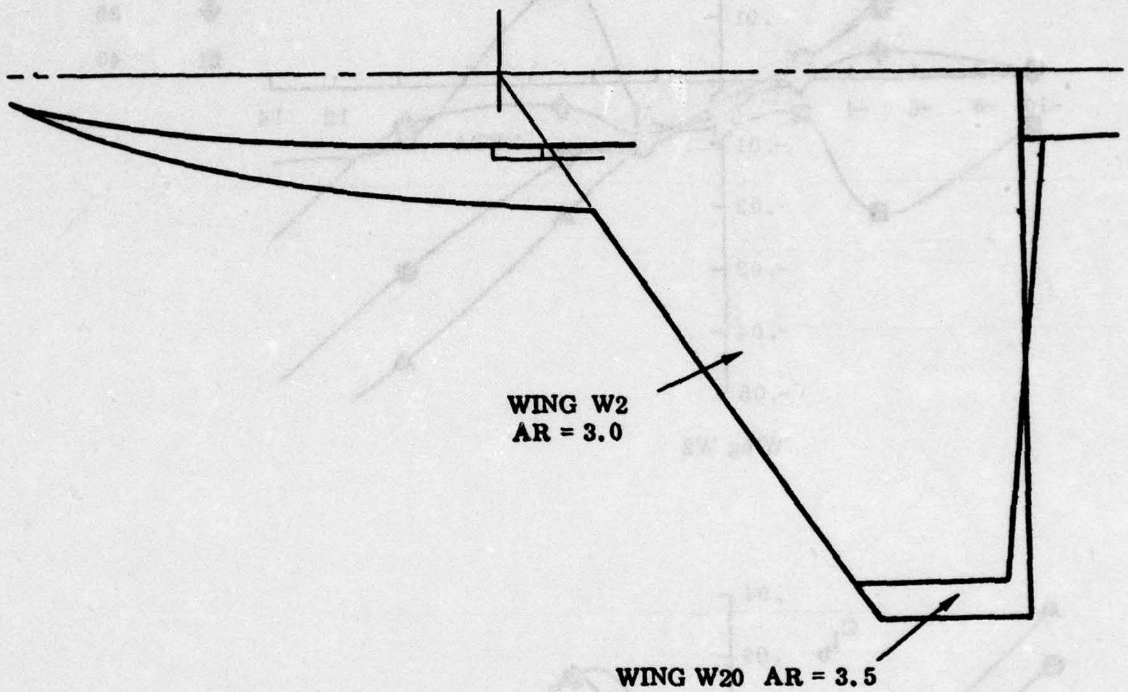


Figure 129. Variation in Wing Aspect Ratio (W2, W20)

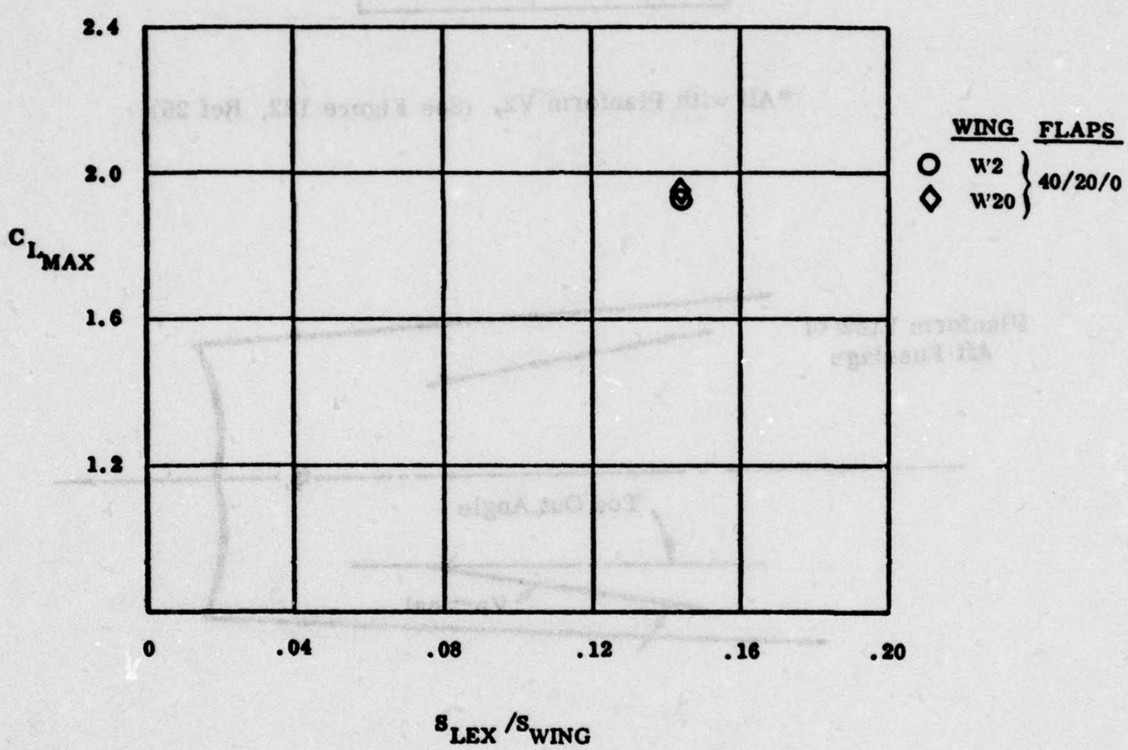


Figure 130. Effect of Wing Aspect Ratio on $C_{L_{MAX}}$

VERTICAL*	TOE OUT
V2	0
V10	1°
V11	3°

*All with Planform V2, (See Figure 122, Ref 25)

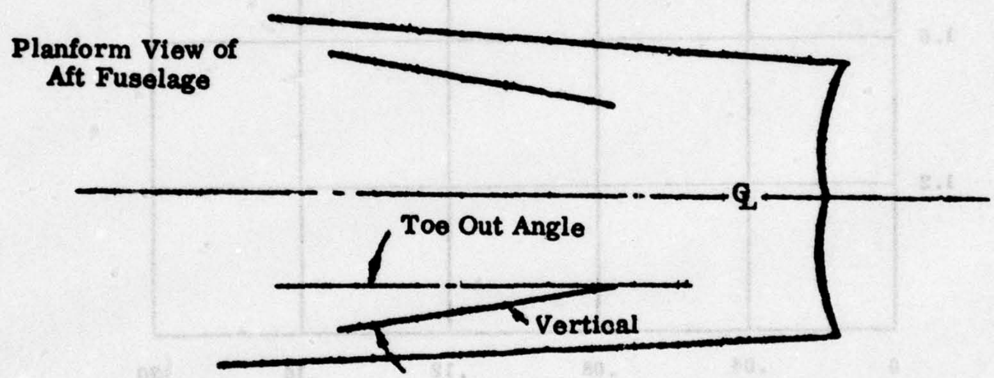


Figure 131. Vertical Tails (V2, V10, V11)

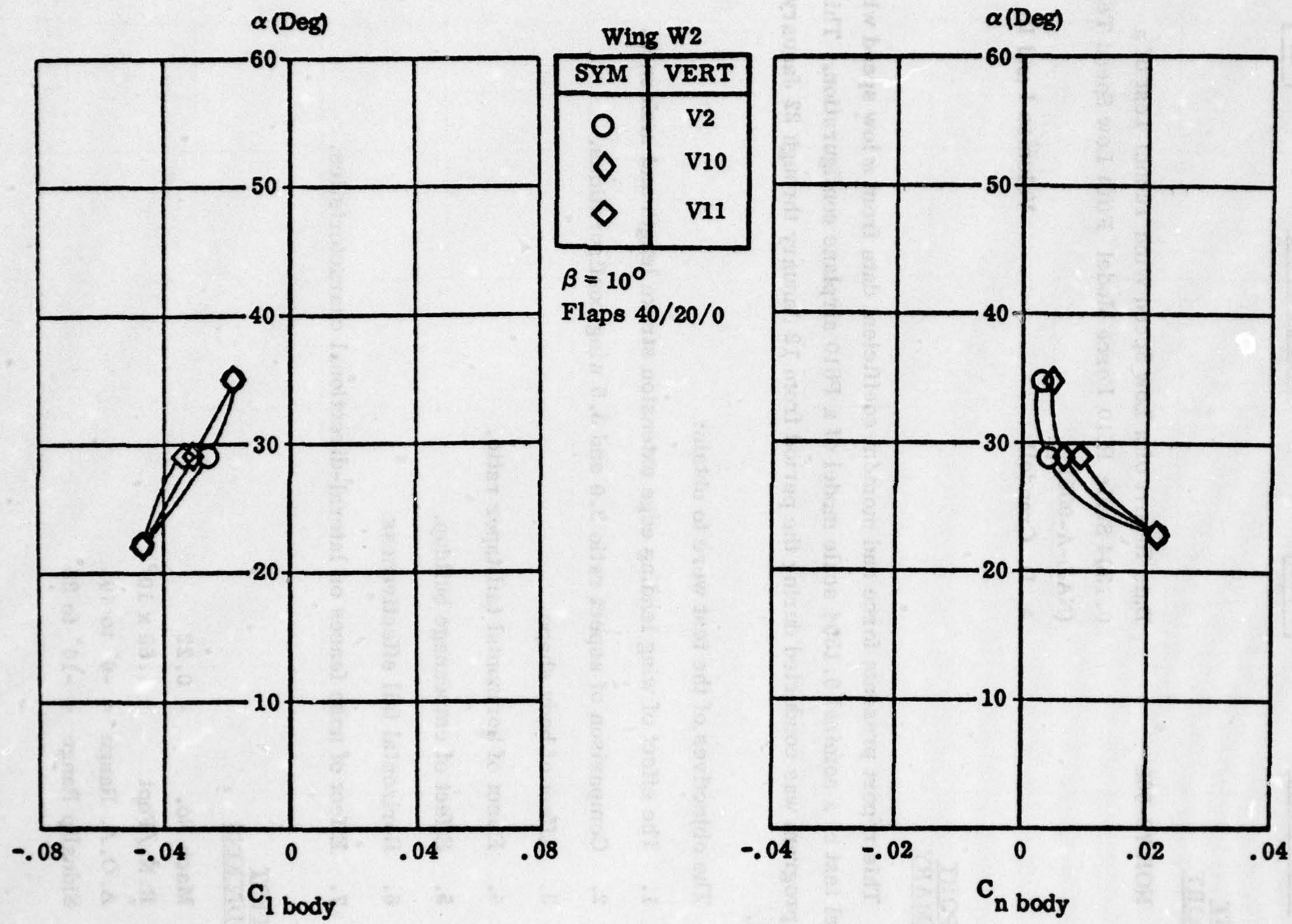


Figure 132. Effect of Vertical Tail Toe-Out

AIRCRAFT **P610** REFERENCE **27**

TEST REPORT

NOR 72-069 — Data Report of a Low Speed Wind Tunnel Test of a 0.1304 Scale P610 Force Model Fifth Low Speed Test (NAL-A-965)

A. D. Crandell — Volumes I and II

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a nominal 0.1304 scale model of a P610 airplane configuration. This test program was conducted during the period from 12 January through 22 January 1972.

The objectives of the test were to obtain:

1. The effect of wing leading edge extension strake length and incidence.
2. Comparison of aspect ratio 3.0 and 3.5 wing configurations.
3. Effect of body shape.
4. Effect of horizontal tail taper ratio.
5. Effect of empennage buildup.
6. Horizontal tail effectiveness.
7. Effect of nose fences on lateral-directional characteristics.

TEST CONDITIONS

Mach No.	= 0.22
R.N./Foot	= 1.55×10^6
A.O.A. Range	= -6° to 40°
Sideslip Range	= -10° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 133.

CONFIGURATION CHANGE

Sketches of LEX and nose fence configuration changes applicable to this study are shown in Figures 134 and 142.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 135 shows the effect on $C_{L_{MAX}}$ of LEX incidence angles for various LEX planforms, W24-W26, W29-W35 and a flap setting of 40°/20°/0°.

Figures 136 through 139 shows the effect on lateral/directional stability of various LEX planform and incidence angles, W24-W26 and W29-W35 with a flap setting of 40°/20°/0°.

Figure 140 shows the effect on $C_{L_{MAX}}$ of the following items:

LEX cross-section W24 and W28

LEX strake, W24 and W29 at 0° incidence

LEX strake, W25 and W31 at 2° incidence

LEX strake, W26 and W30 at 4° incidence.

Figure 141 shows the effect on $C_{L_{MAX}}$ of LEX strake length (W25, W32 and W33 at 2° incidence) and (W26, W34 and W35 at 4° incidence).

Figure 143 shows the effect on lateral/directional stability of top nose fence M1 and top and bottom nose fences M1 and M2.

Data effects for objectives 2 through 6 listed above was either insufficient or not considered pertinent.

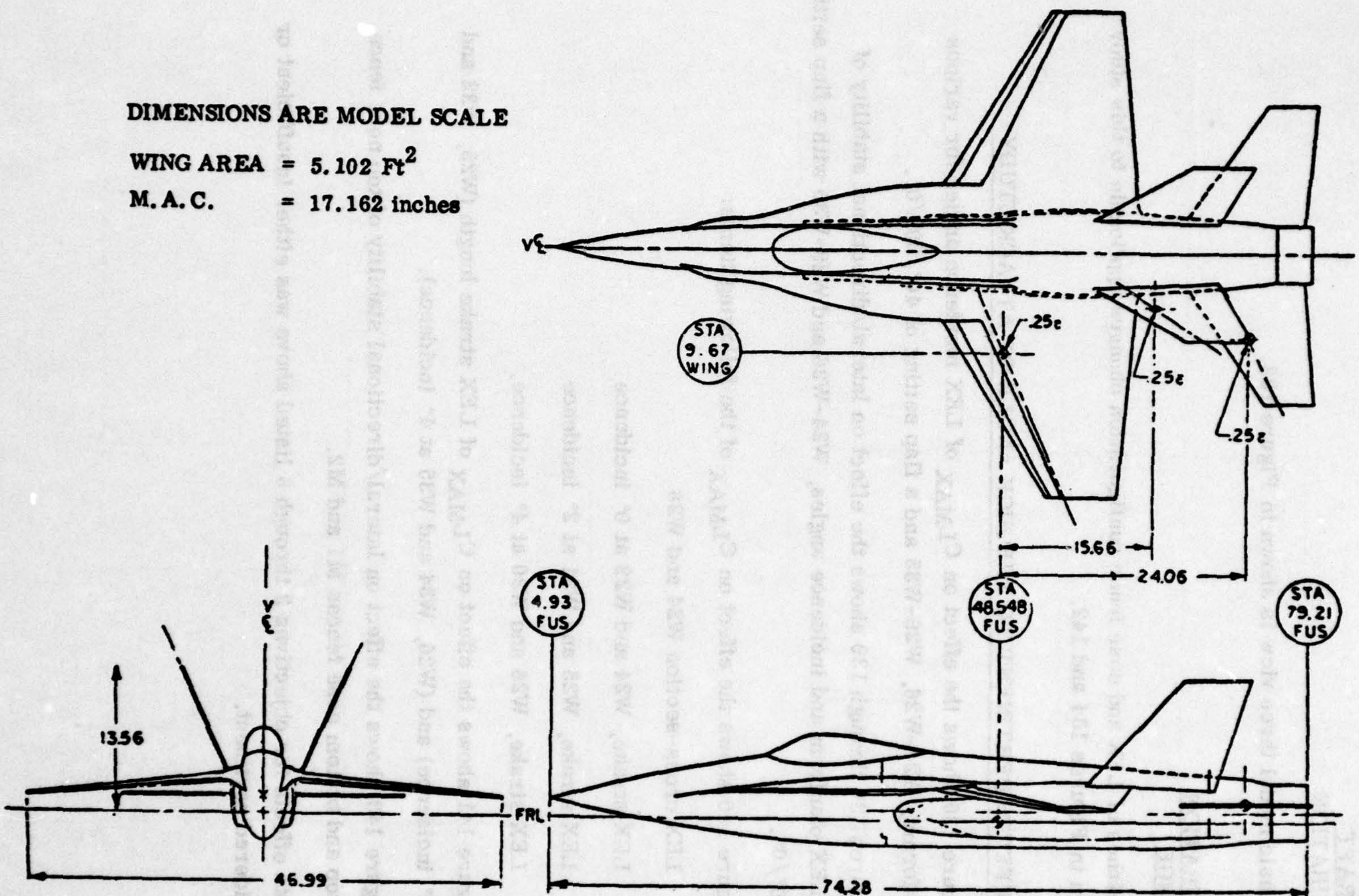
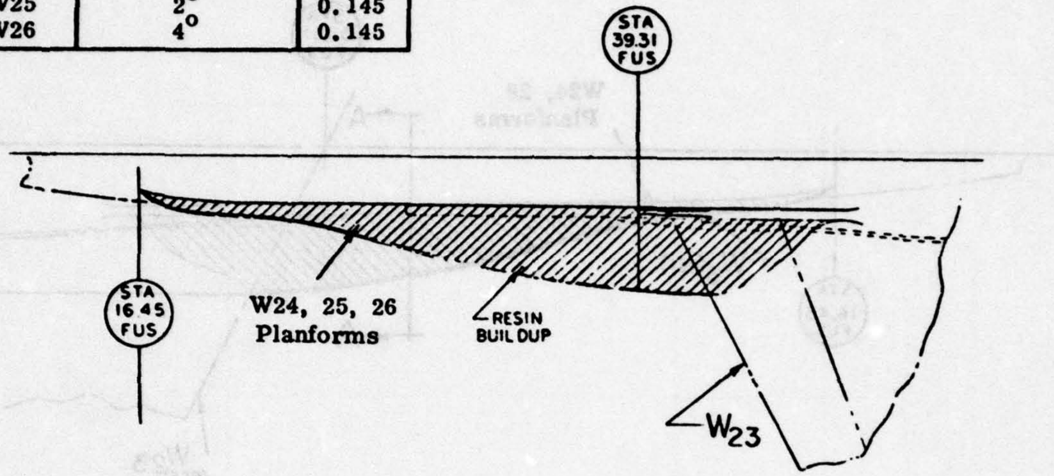


Figure 133. General Three View

LEX	LEX Incidence	S_L/S_W
W24, 28	0^o	0.145
W25	2^o	0.145
W26	4^o	0.145



LEX	LEX Incidence	S_L/S_W
W29	0^o	0.13
W30	4^o	0.13
W31	2^o	0.13

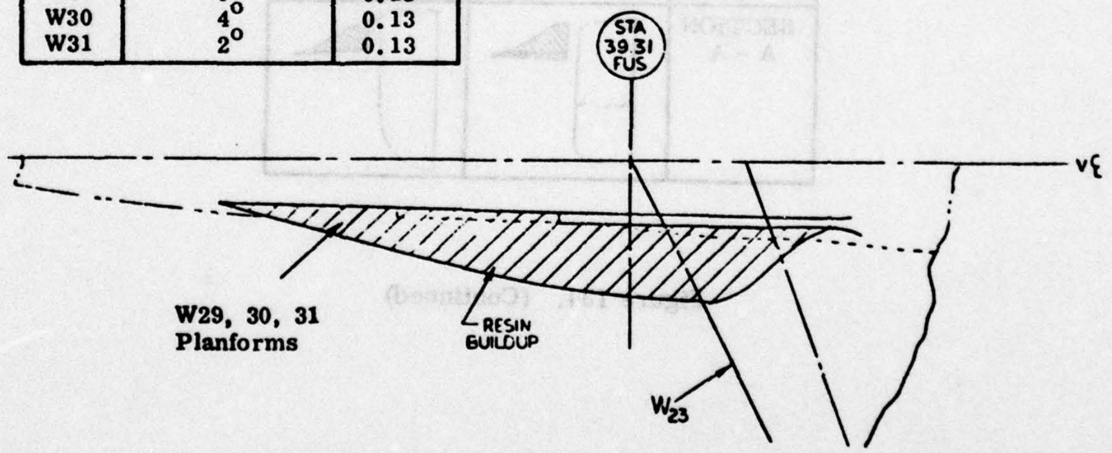
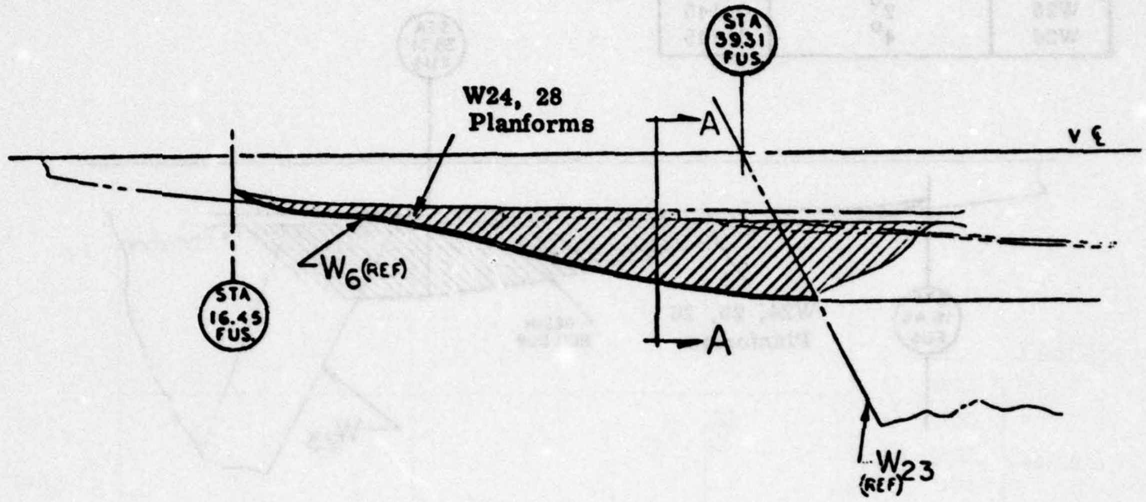


Figure 134. Lex Configurations



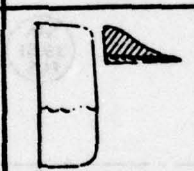
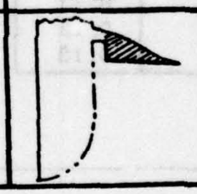
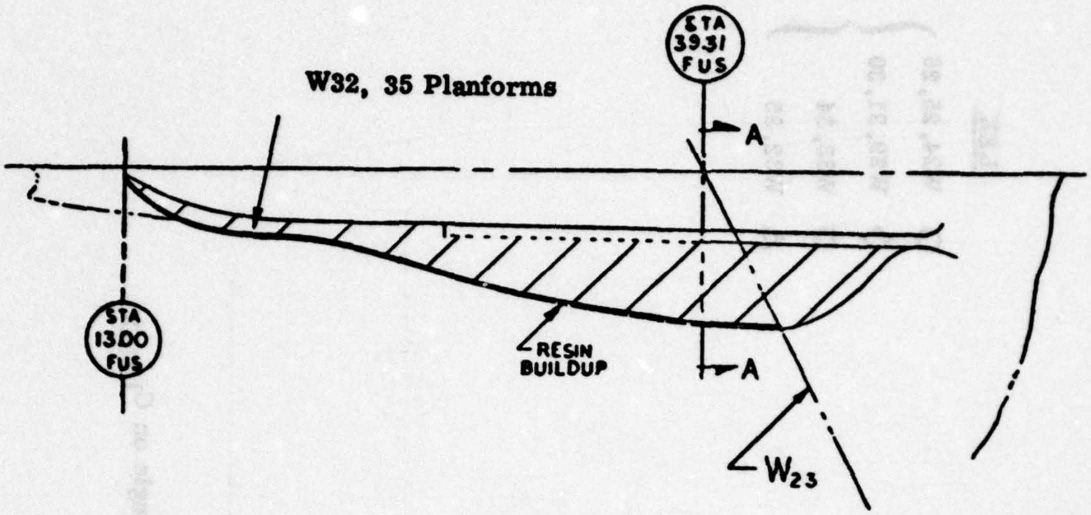
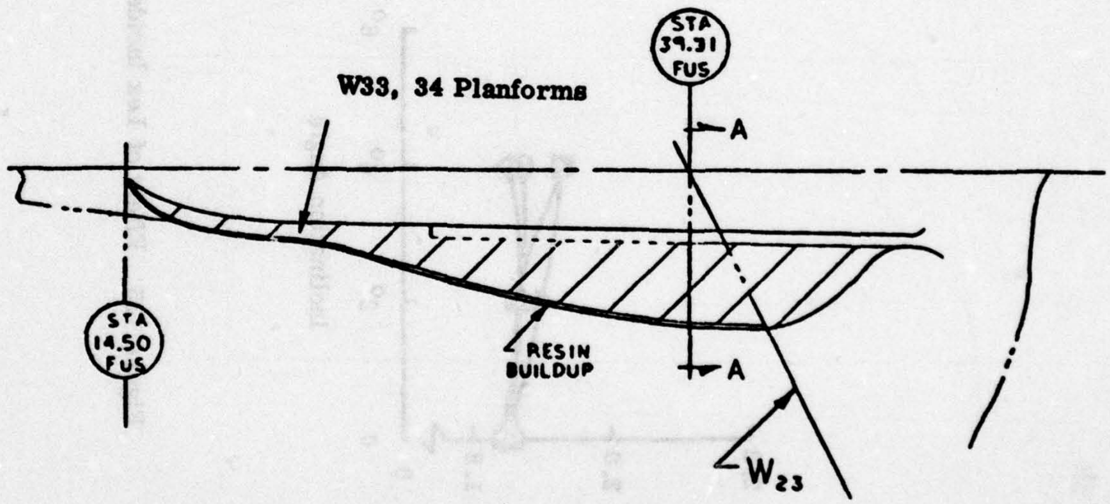
LEX	W24	W28
SECTION A - A		

Figure 134. (Continued)





LEX	LEX Incidence	S_L / S_W
W32	2^o	0.165
W33	2^o	0.163
W34	4^o	0.163
W35	4^o	0.165

Figure 134. (Concluded)

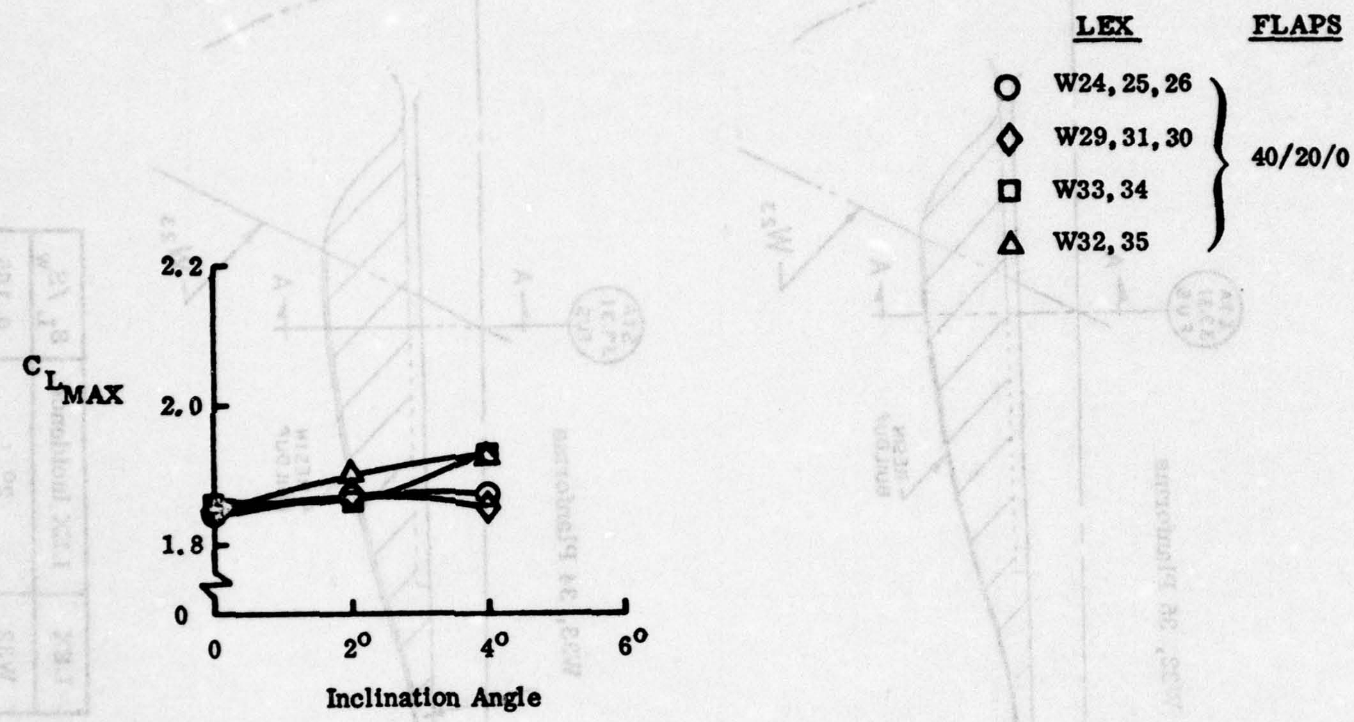


Figure 135. Effect of Lex Incidence Angle on $C_{L_{MAX}}$

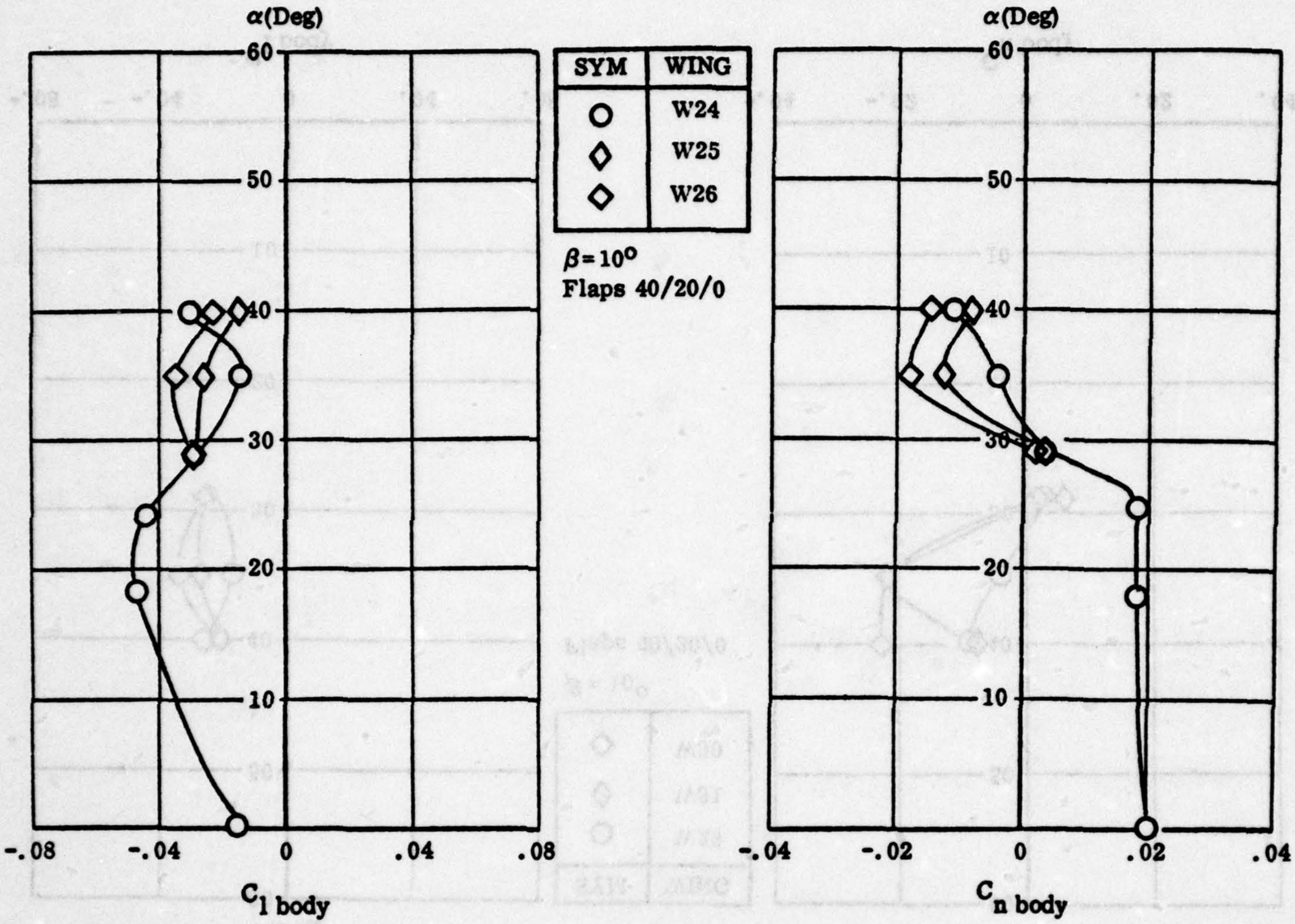


Figure 136. Effect of Lex Incidence Angle

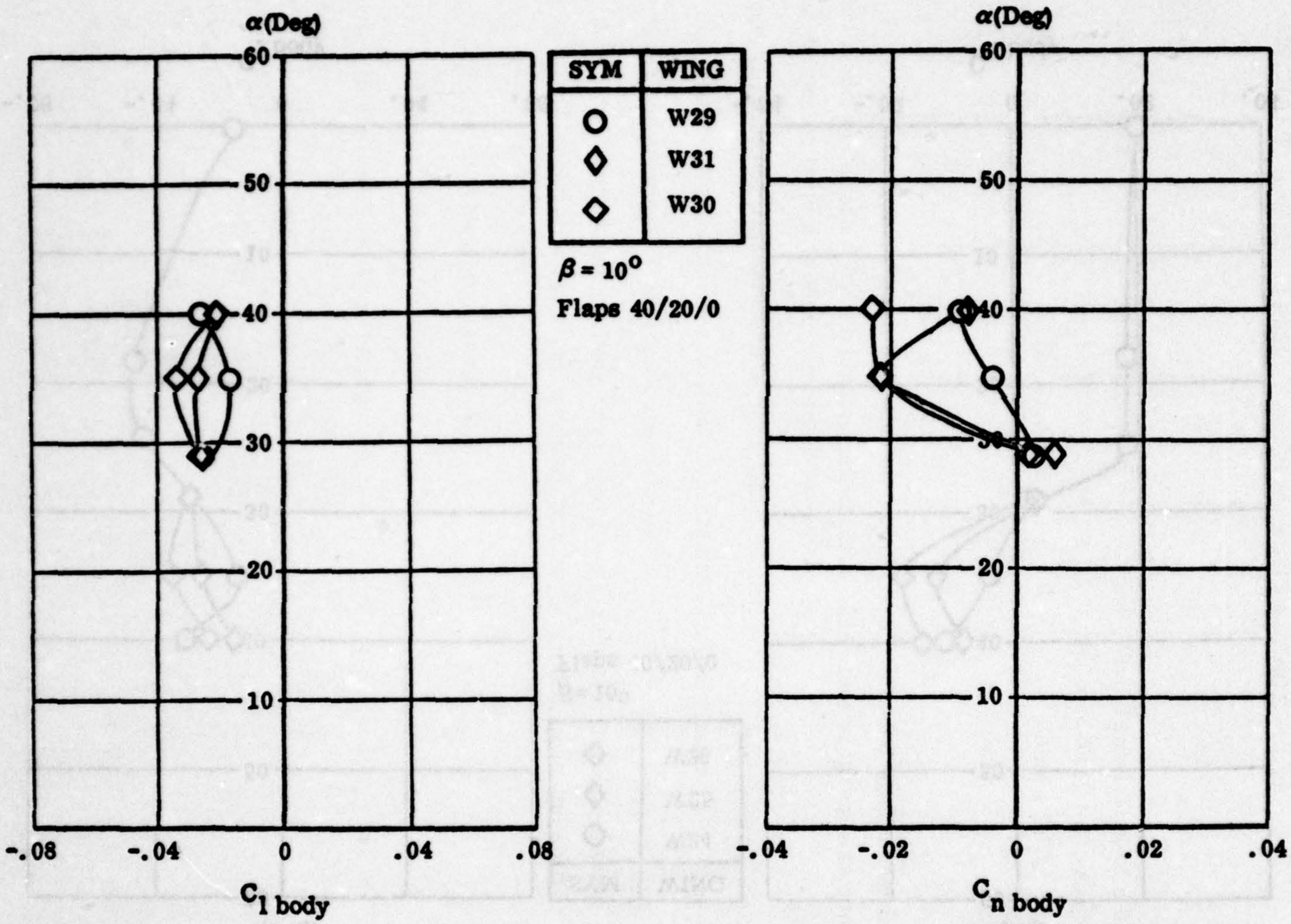


Figure 137. Effect of Lex Incidence Angle

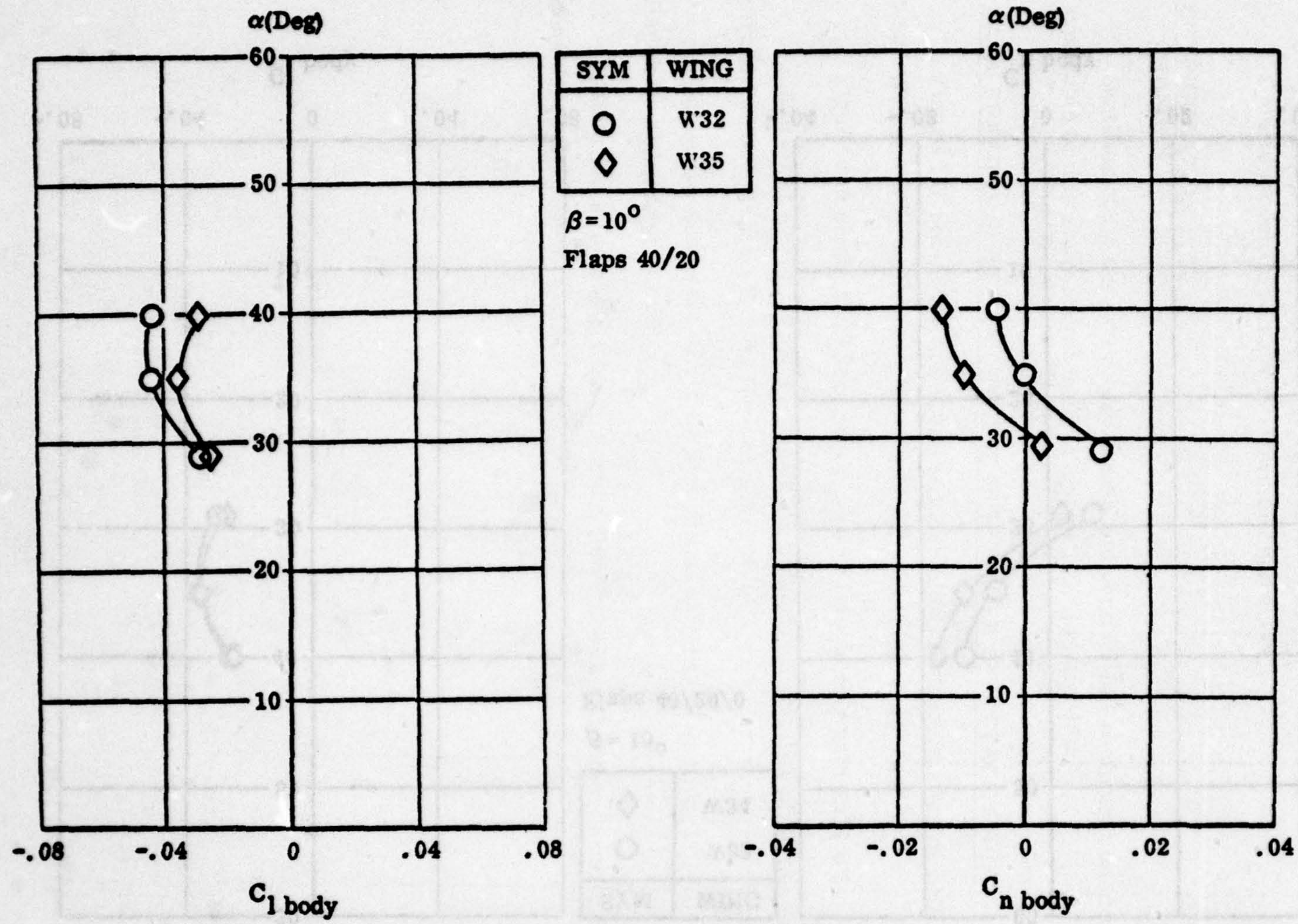


Figure 138. Effect of Lex Incidence Angle

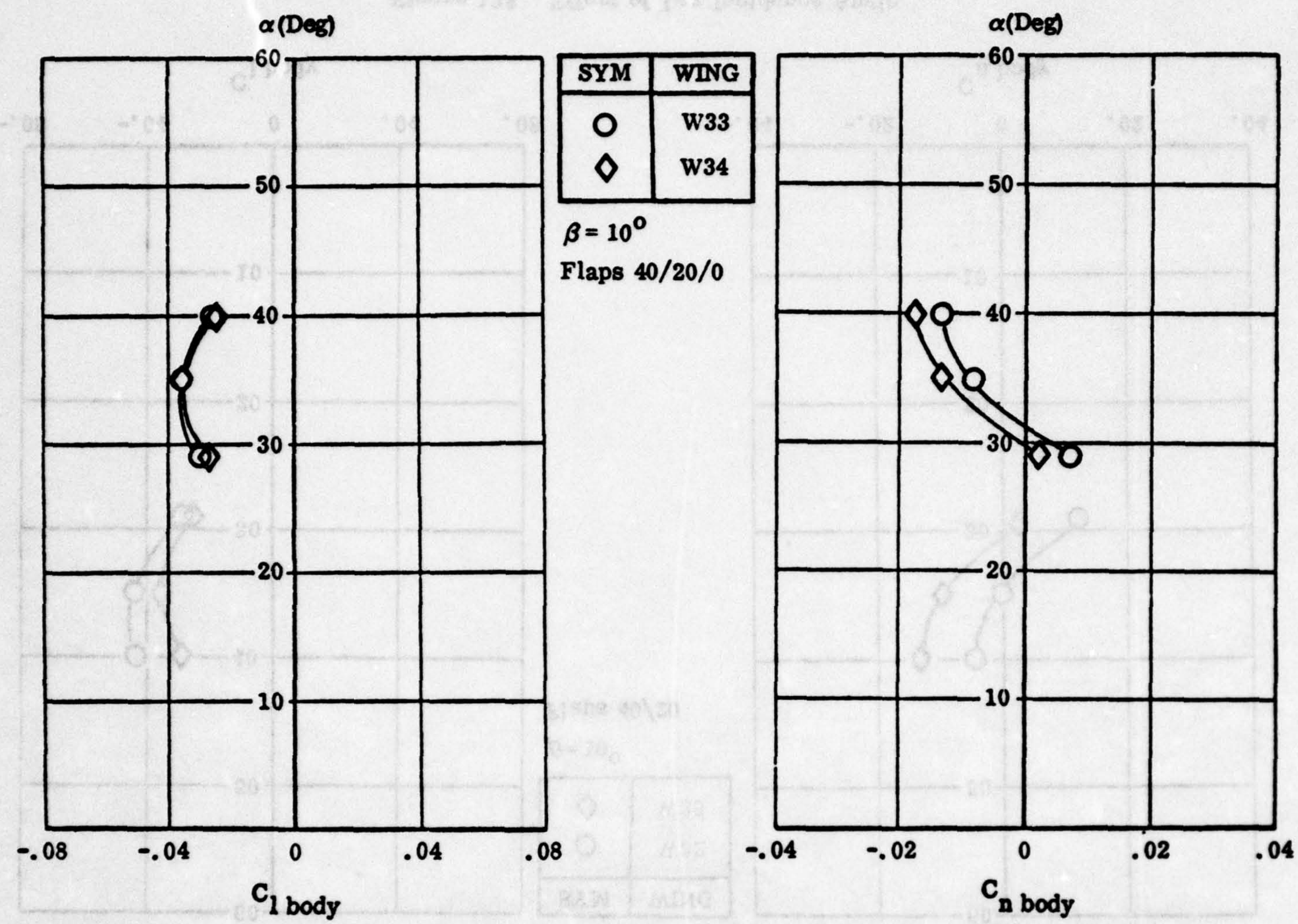


Figure 139. Effect of Lex Incidence Angle

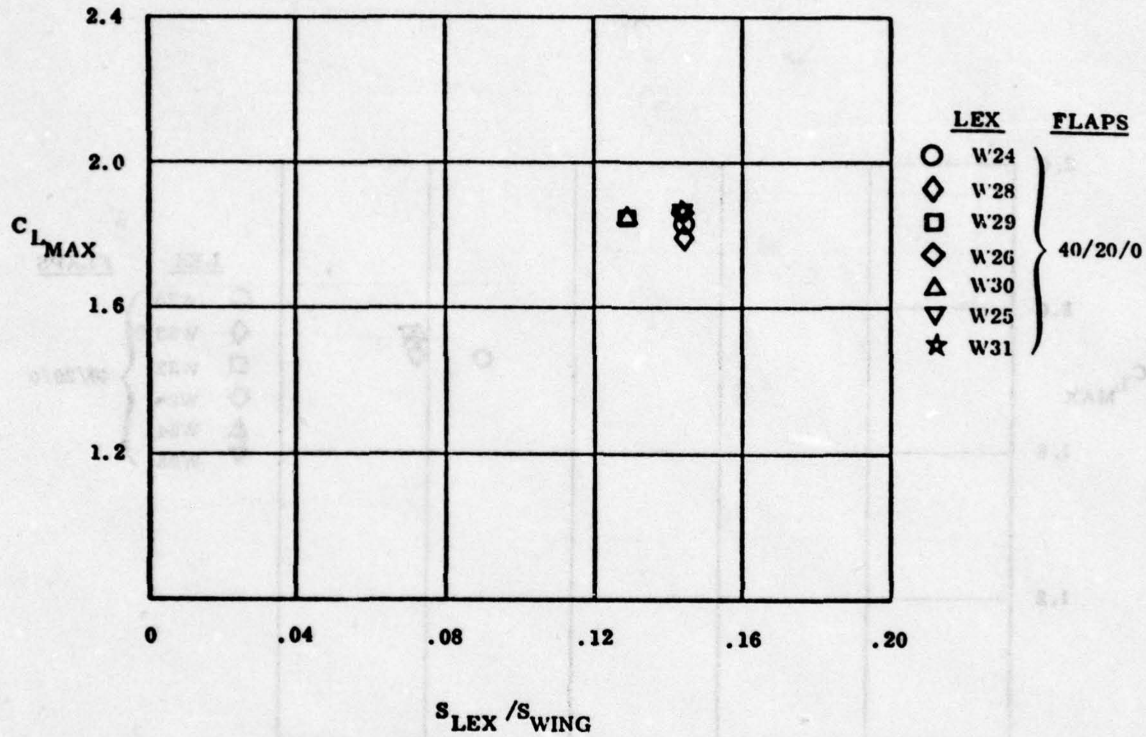


Figure 140. Effect of Lex Cross Section and Lex Strake on $C_{L_{MAX}}$

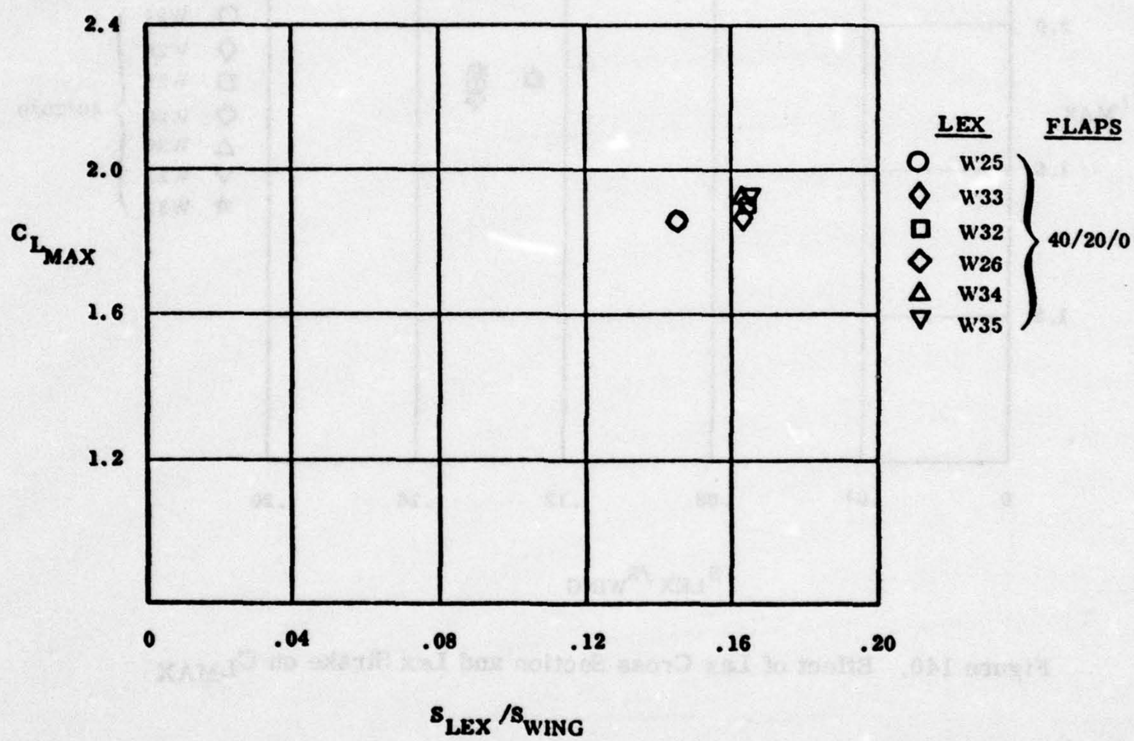


Figure 141. Effect of Lex Strake Length on $C_{L_{MAX}}$

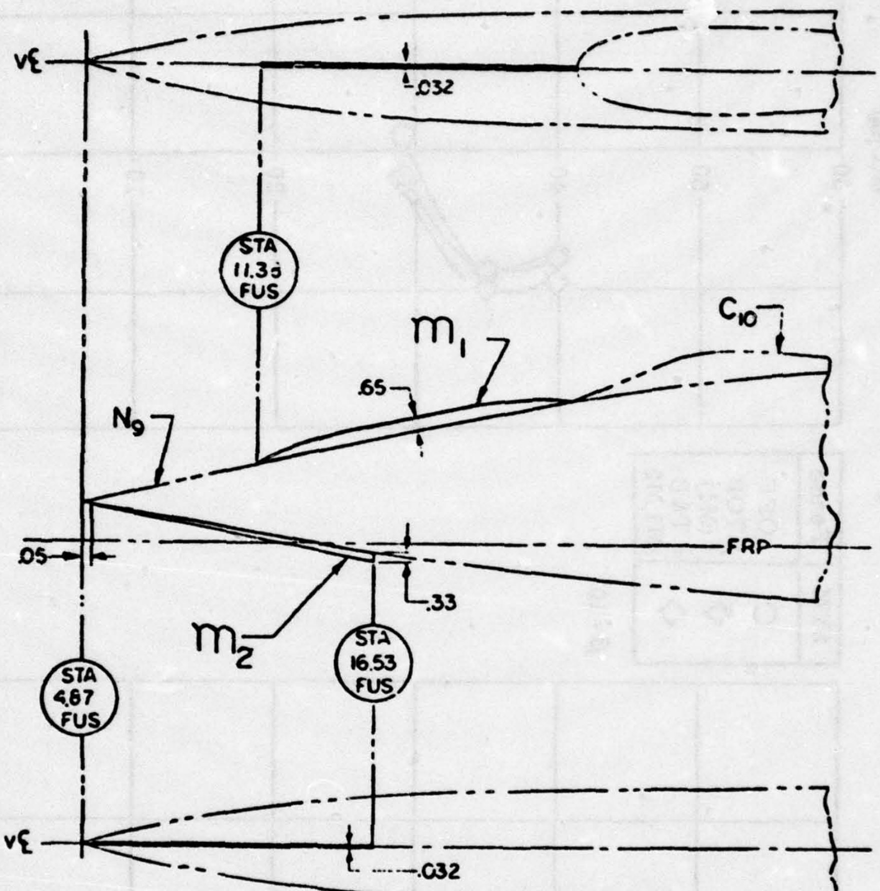


Figure 142. Nose Fences (m1, m2)

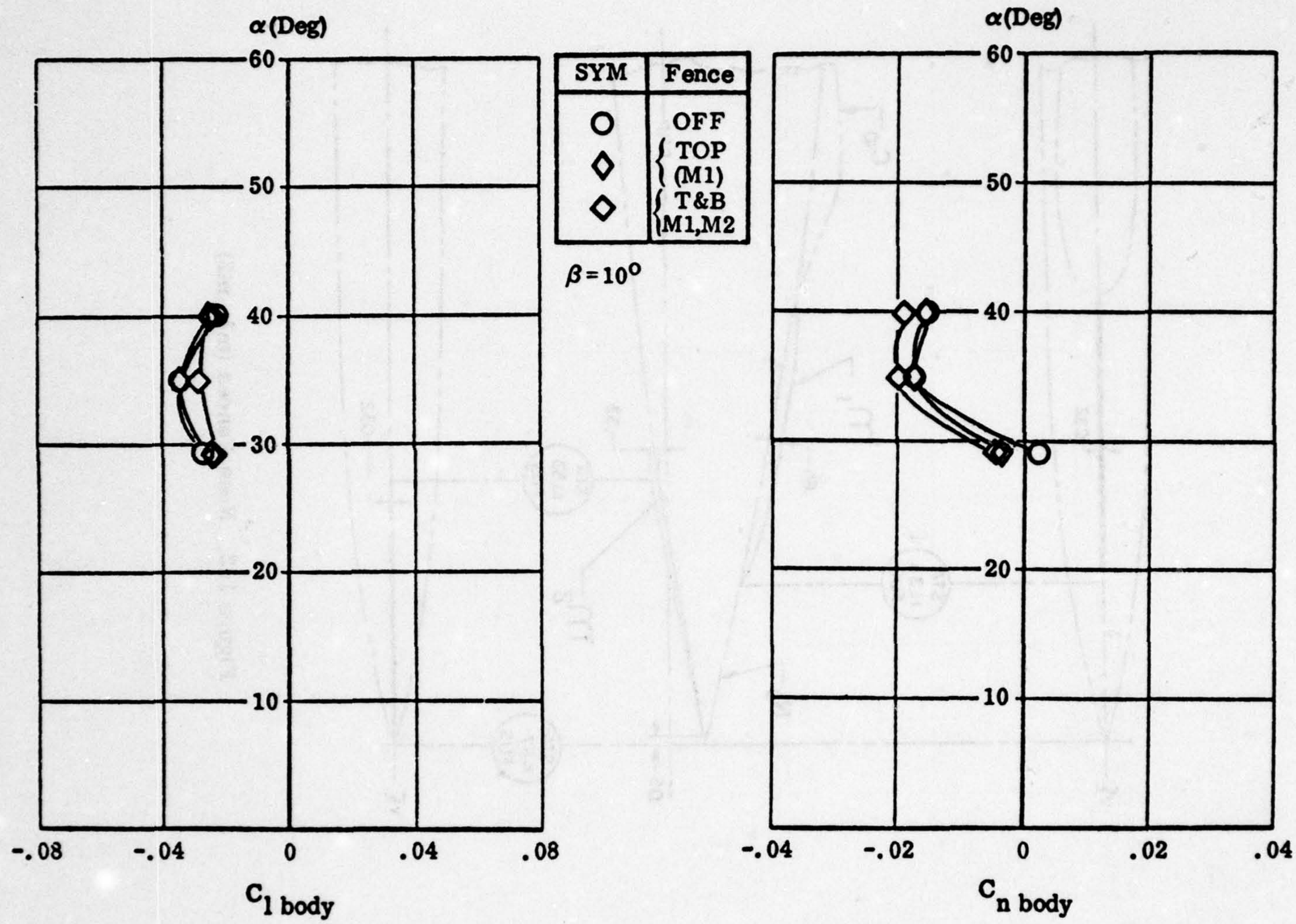


Figure 143. Effect of Nose Fences

SECTION VI

P630 TEST DATA

Early testing of the P630 configuration was carried out in the Northrop 7 x 10 ft low speed wind tunnel using the P600, 0.121 scale model (and its nomenclature). Almost all these tests were concerned with landing and take off performance, and hence, were mainly run with full flap settings and the gear down. Little information useful to this study is, therefore, available from these tests, and this is found only in the first P630 tests (NAL-A-061), a summary of which follows.

AIRCRAFT P630 **REFERENCE** 28

TEST REPORT

NOR 74-012	Data Report of a Low Speed Wind Tunnel Test of a 0.121 Scale P630 Force Model Low Speed Test NAL-A-061
	A. D. Crandell Volume I-III

REPORT SUMMARY

This report presents force and moment data from a low speed wind tunnel test of a 0.121 scale model of a P630 airplane configuration. This test program was conducted during the period from 8 October through 2 November 1973.

Primary purposes of the test were to determine:

1. Basic Longitudinal and Lateral-Directional Characteristics
2. Comparison of Wing Tip Configurations
3. Wing Leading and Trailing Edge Flap Study, including flap effectiveness, trailing edge flap gap and overhang, trailing edge flap span and split trailing edge flap
4. Effect of Wing and Nose Strakes
5. Nose and Canopy Modification
6. Horizontal Tail Effectiveness

TEST CONDITIONS

Mach No.	= 0.22
R.N./Foot	= 1.5×10^6
A.O.A. Range	= -6° to 40°
Sideslip Range	= -10° to 20°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 144.

CONFIGURATION CHANGES

Sketches of LEX strake, nose strake and vertical tail configuration changes applicable to this study are shown in Figures 145, 146 and 150.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 147 shows the effect on the longitudinal characteristics of LEX strake W54, W71 and W54 with nose strake S27, all with flaps at 40°/20°/0°.

Figure 148 shows the effect on $C_{L_{MAX}}$ of flap setting with LEX W54.

Figure 149 shows the effect on lateral/directional stability of strake off, nose strake S27 and LEX W71, with flaps at 40°/20°/0°.

Figure 151 shows the effect on directional stability of vertical tail V35 with a flap deflection of 40°/20°/0°.

Data effects for objectives 2, 5 and 6 listed above was either insufficient or not considered pertinent.

DIMENSIONS ARE MODEL SCALE

WING AREA = 5.140 Ft^2
M.A.C. = 15.65 inches

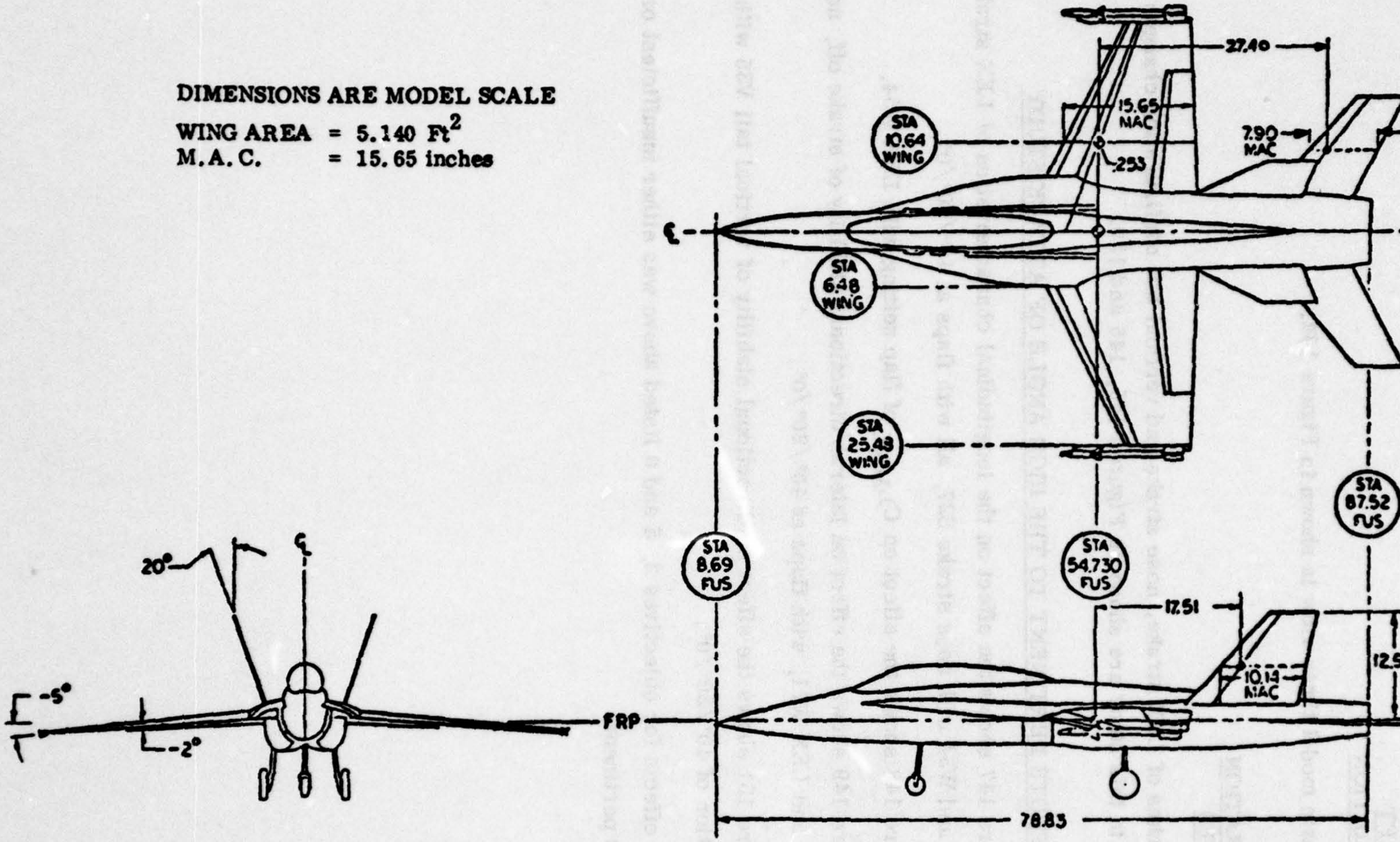


Figure 144. General Three View

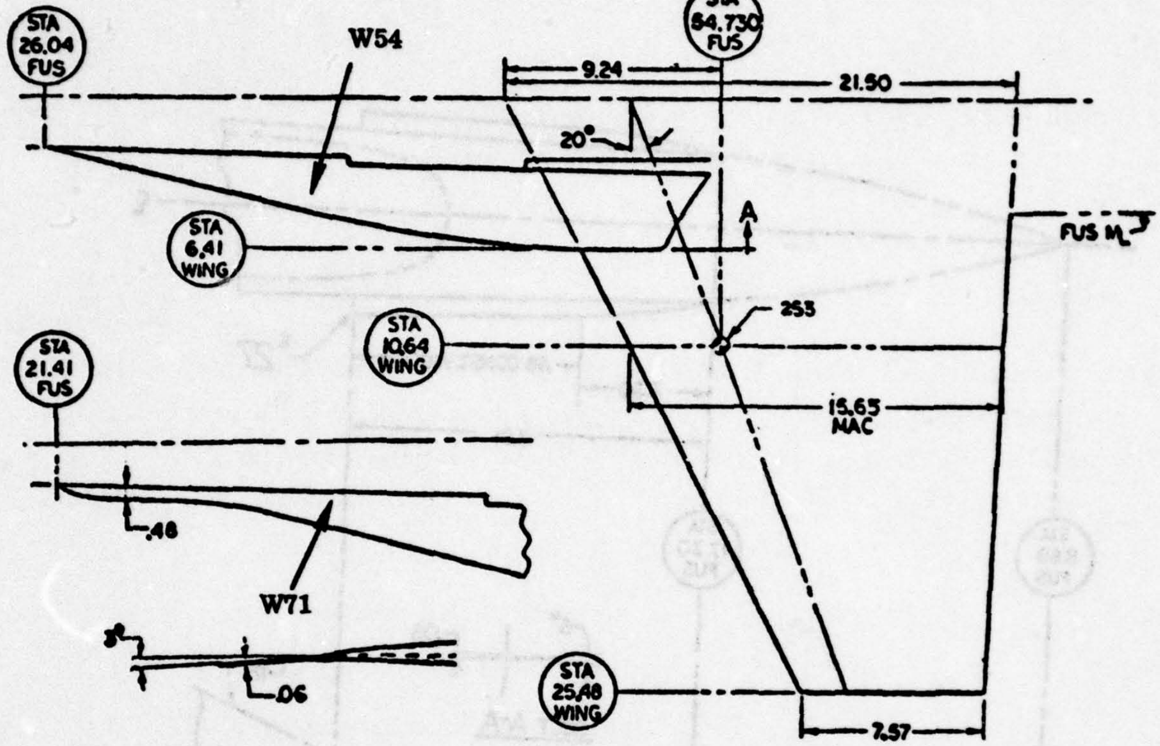


Figure 145. Lex Strakes, W54 & W71

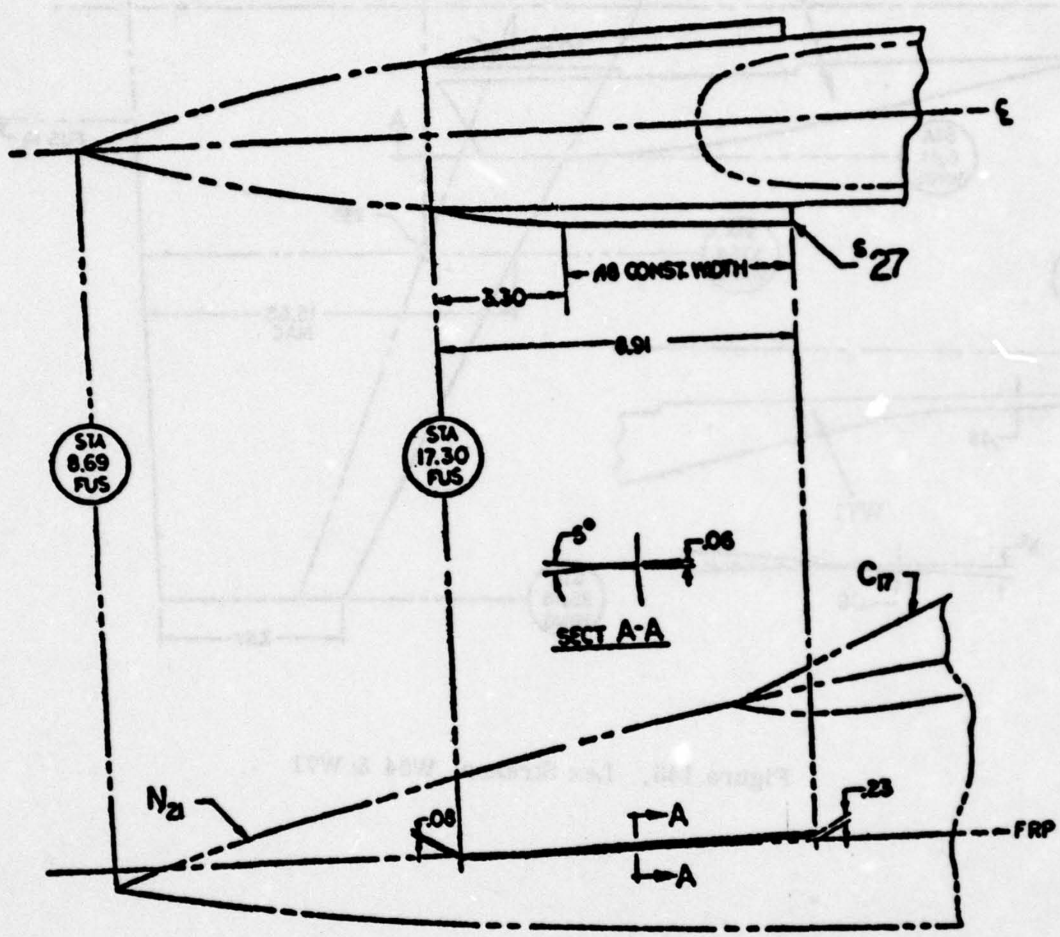


Figure 146. Nose Strakes, S27

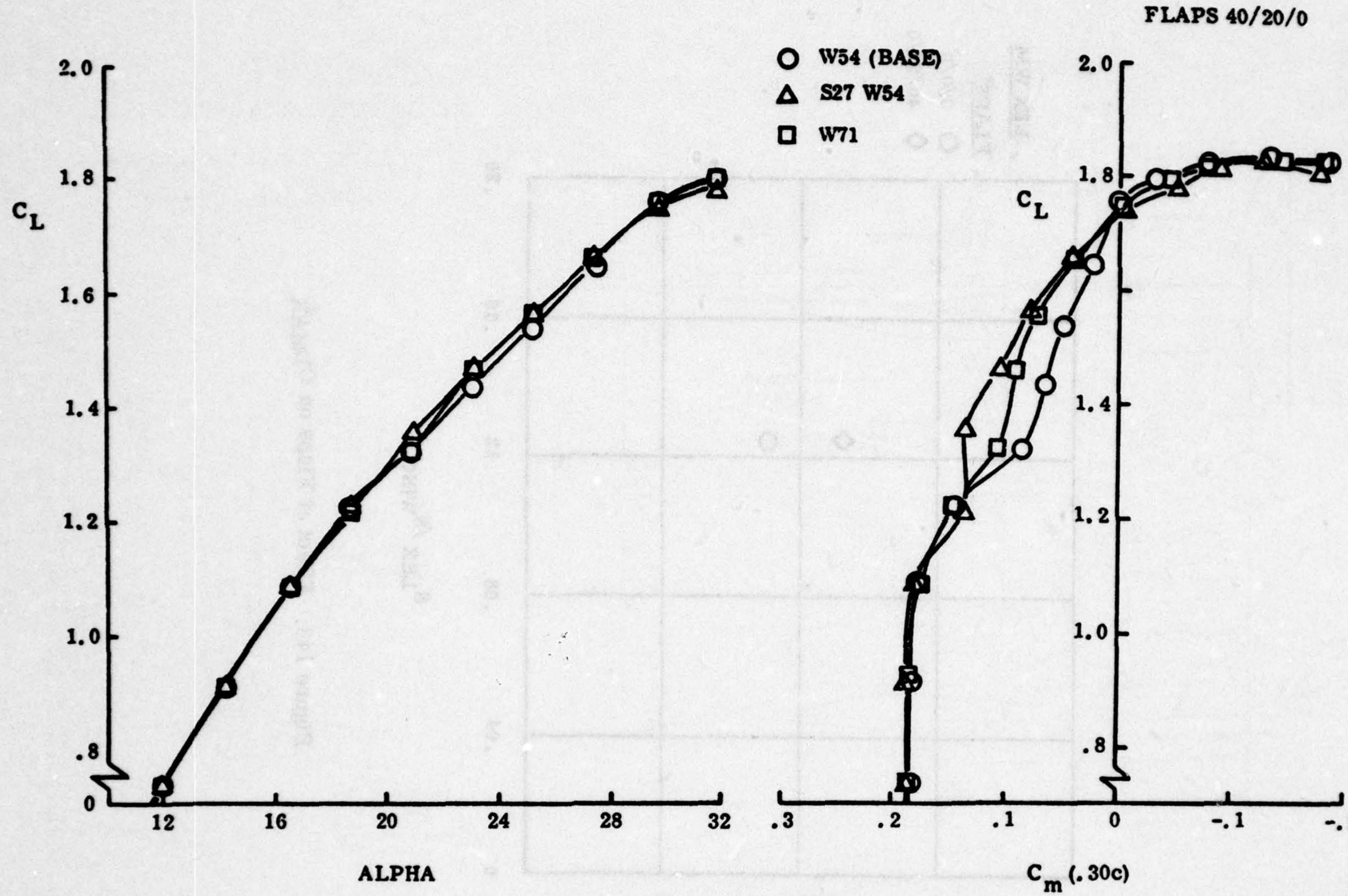


Figure 147. Effect of Strakes

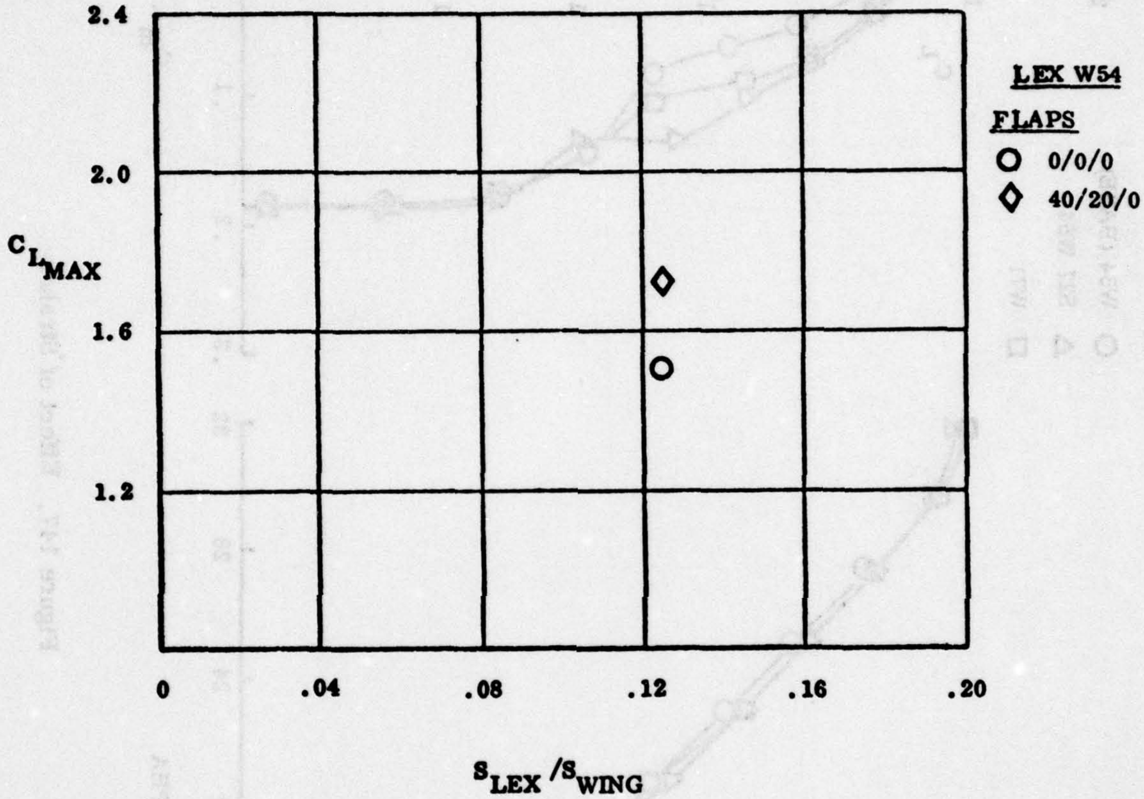


Figure 148. Effect of Flaps on $C_{L_{MAX}}$

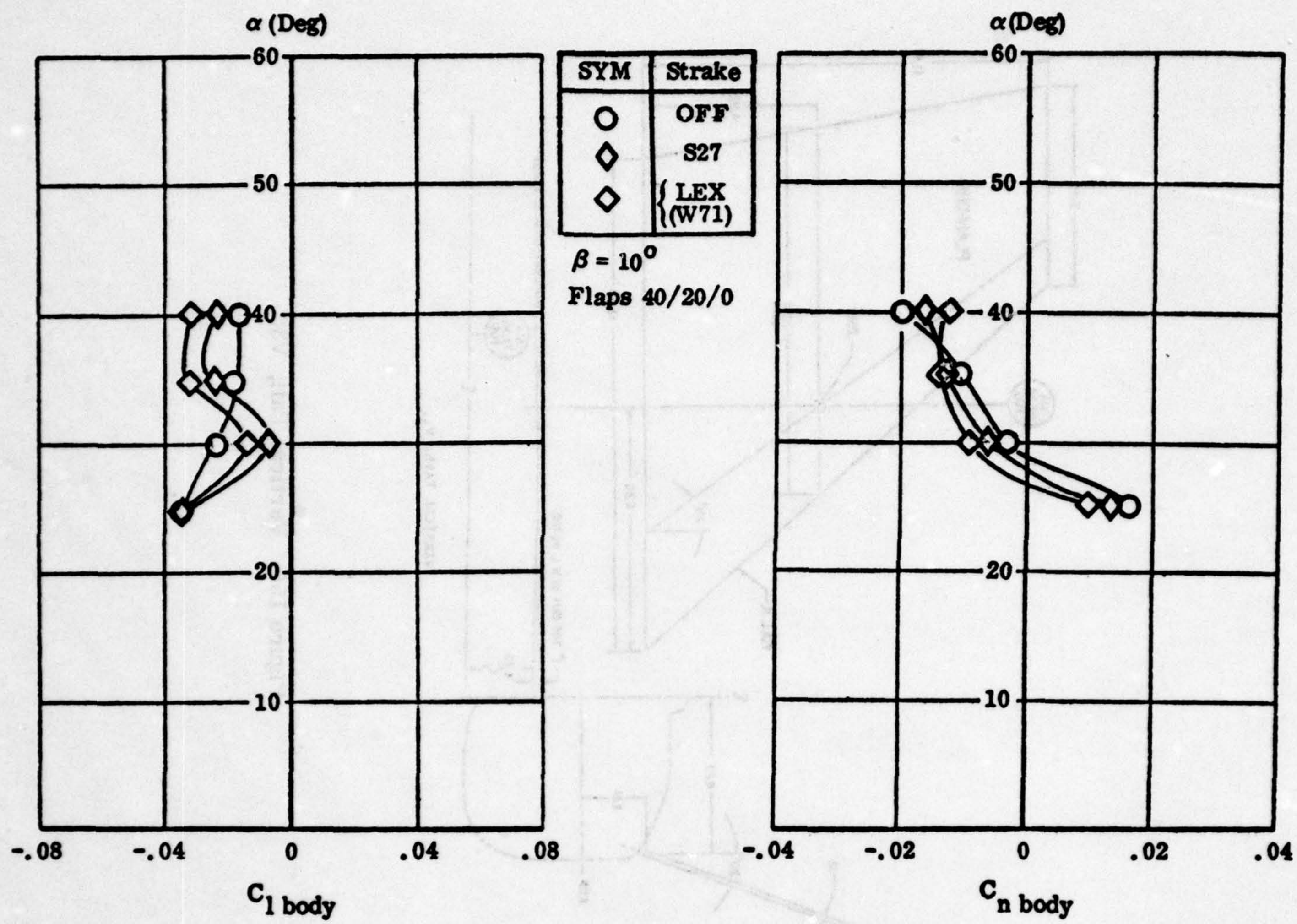


Figure 149. Effect of Various Strakes

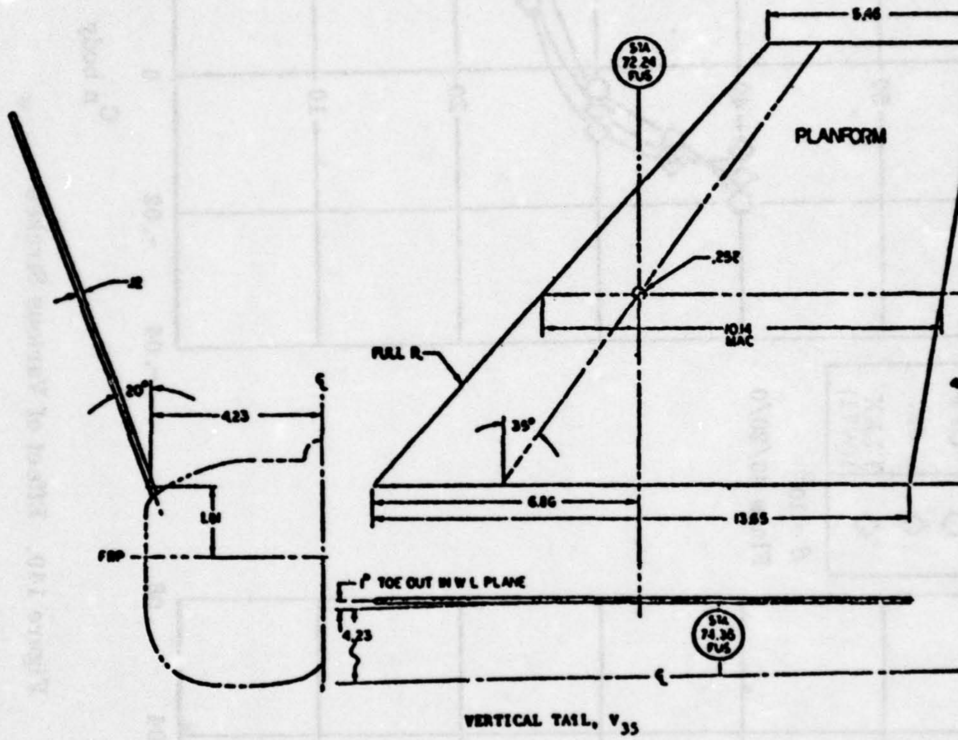


Figure 150. Vertical Tail, V35

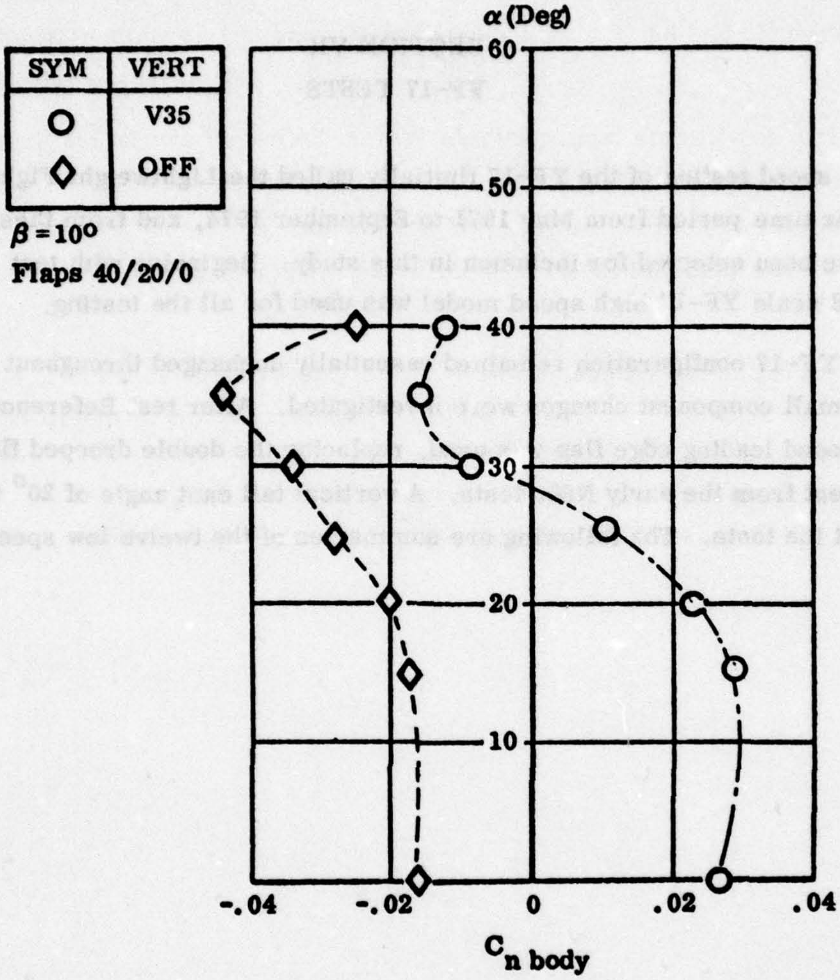


Figure 151. Effect of Vertical Tail

SECTION VII
YF-17 TESTS

Low speed testing of the YF-17 (initially called the Lightweight Fighter, LWF) covered the time period from May 1971 to September 1974, and from these tests, twelve have been selected for inclusion in this study. Beginning with test Reference 33, a 0.08 scale YF-17 high speed model was used for all the testing.

The YF-17 configuration remained essentially unchanged throughout this period, and only small component changes were investigated. After test Reference 33 , a single drooped leading edge flap was used, replacing the double drooped flap which had been present from the early N300 tests. A vertical tail cant angle of 20° was used throughout the tests. The following are summaries of the twelve low speed tests.

AIRCRAFT **YF-17** REFERENCE **29**

TEST REPORT

NOR 72-084 — Data Report of a 0.05 scale LWF Force Model Low Speed Wind Tunnel Test
W.P. Rehm

REPORT SUMMARY

This report presents force and moment coefficient plotted data for a low speed wind tunnel test of a 0.05 scale preliminary model of the LWF airplane. This test program was conducted during the period from 16 May to 19 May 1971. The objectives of the test were to obtain:

1. Effect of Vertical Tails Reduced in size and Moved Aft.
2. Effect of Triangular Nose Shape
3. Horizontal Tail Effectiveness
4. Effect of Angle of Attack in Sideslip.

TEST CONDITIONS

Mach No. = 0.29
R.N./Foot = 2.0×10^6
A.O.A. Range = -6° to 41°
Sideslip Range = -10° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 152.

CONFIGURATION CHANGES

Sketches of nose cross section configuration changes applicable to this study are shown in Figure 153.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Testing of nose cross-sections N14 and N17 showed no effect on the longitudinal characteristics and lateral/directional data was unavailable for analysis.

Data effects for objectives 1, 3 and 4 listed above was insufficient for inclusion.

DIMENSIONS AND MODEL SCALE

Wing Area = 0.875 Ft^2

M.A.C. = 6.464 inches

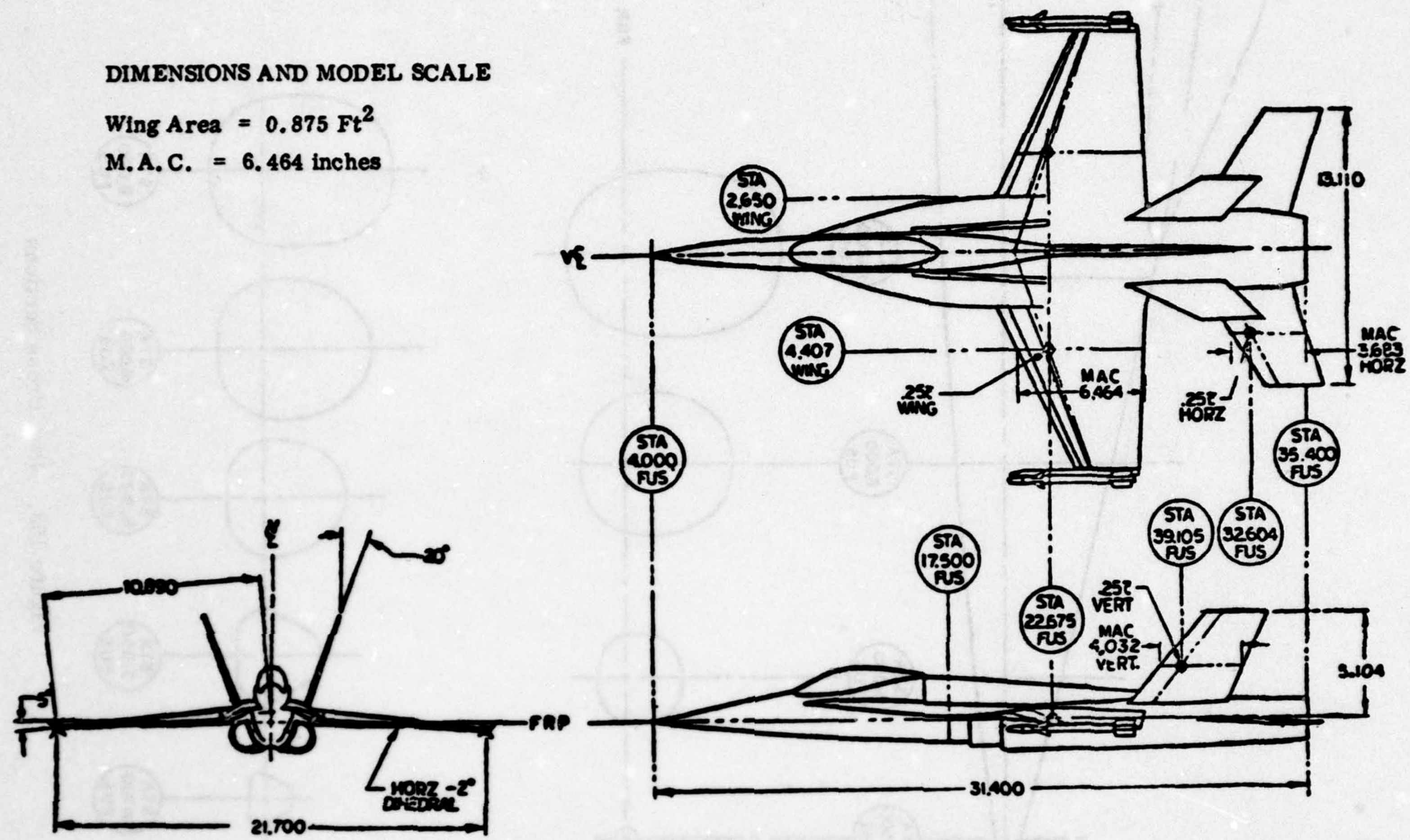
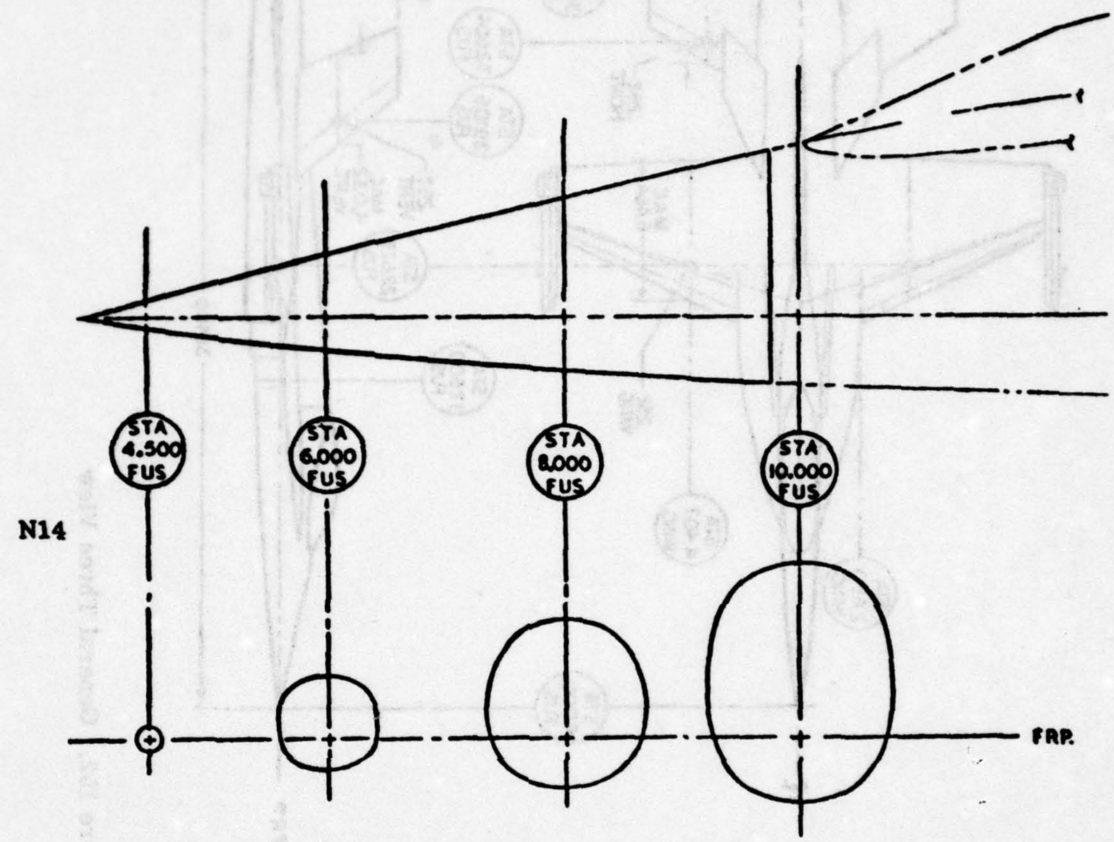


Figure 152. General Three View

NOSES



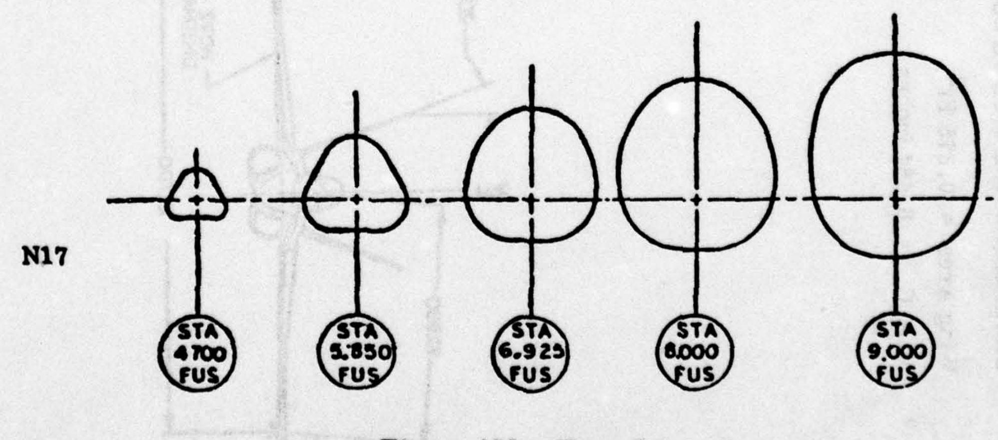


Figure 153. Nose Cross Sections

AIRCRAFT **YF-17** REFERENCE **30**

TEST REPORT

NOR 72-187 **Data Report of a Low Speed Wind Tunnel Test of 0.121 Scale Advanced Fighter First Model, First Low Speed Test**

A.D. Crandall

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of an existing 0.121 scale preliminary model of a P600 airplane configuration. The test was a low speed aerodynamic investigation to test configuration variations. This test program was conducted during the period from 16 June through 18 July 1972.

The objectives of the test were to obtain:

1. Effect of leading edge extension strake length
2. Effect of slot geometry
3. Effect of nose shape
4. Effect of nose strakes
5. Comparison of wing leading edge flap deflection angle
6. Effect of wing trailing edge flap deflection angle
7. Empennage build-up
8. Horizontal tail effectiveness
9. Comparison of vertical tail planforms
10. Aileron and rolling tail effectiveness
11. Rudder effectiveness
12. Effect of speed brakes

13. Effect of wing tip strake

14. Wing tip missile build-up

15. Effect of stores

16. Lateral-Directional characteristics in pitch and sideslip

17. Effect of Reynolds number

18. Effect of longitudinal grit pattern on nose.

TEST CONDITIONS

Mach No.	=	0.22
R.N./Foot	=	1.5×10^6
A.O.A. Range	=	-6^o to 40^o
Sideslip Range	=	-10^o to 25^o

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 154.

CONFIGURATION CHANGES

Sketches of LEX and Strake planform, nose cross section, nose strakes and vertical tail configuration changes applicable to this study are shown in Figures 155, 158, 160, and 165.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 156 shows the effect on $C_{L_{MAX}}$ of strake length, W54, W56 and W57, and flap deflection with strake W54.

Figure 157 shows the effect on lateral/directional stability of strake length W54, W56 and W57 with flaps $40^o/20^o/o^o$.

Figure 159 shows the effect on lateral/directional stability of nose cross-section N20, N21 and N22 with flaps $40^o/20^o/0^o$.

Figure 161 shows the effect on lateral/directional stability of nose strake length S7, S8, S9 and no strake, all with flaps 40°/20°/0°. A similar effect is shown for nose strake, S10 off and on in Figure 162. Lateral/directional stability is also shown in Figures 163 and 164 for strakes S2, S5, S6 and combined strakes S2/S6 with flaps 40°/20°/0°.

Figure 166 shows the effect on lateral/directional stability of vertical tail location, V17, V26 and V27. Figure 167 shows a similar effect of vertical tail taper ratio, V27 and V28, and Figure 168 shows the effect of various vertical tails, V17, V22 and V23. All of these vertical tail data were with flaps 40°/20°/0°.

Data effects for objectives 2, 5-8, 10-15, 17 and 18 listed above was either insufficient or not pertinent.

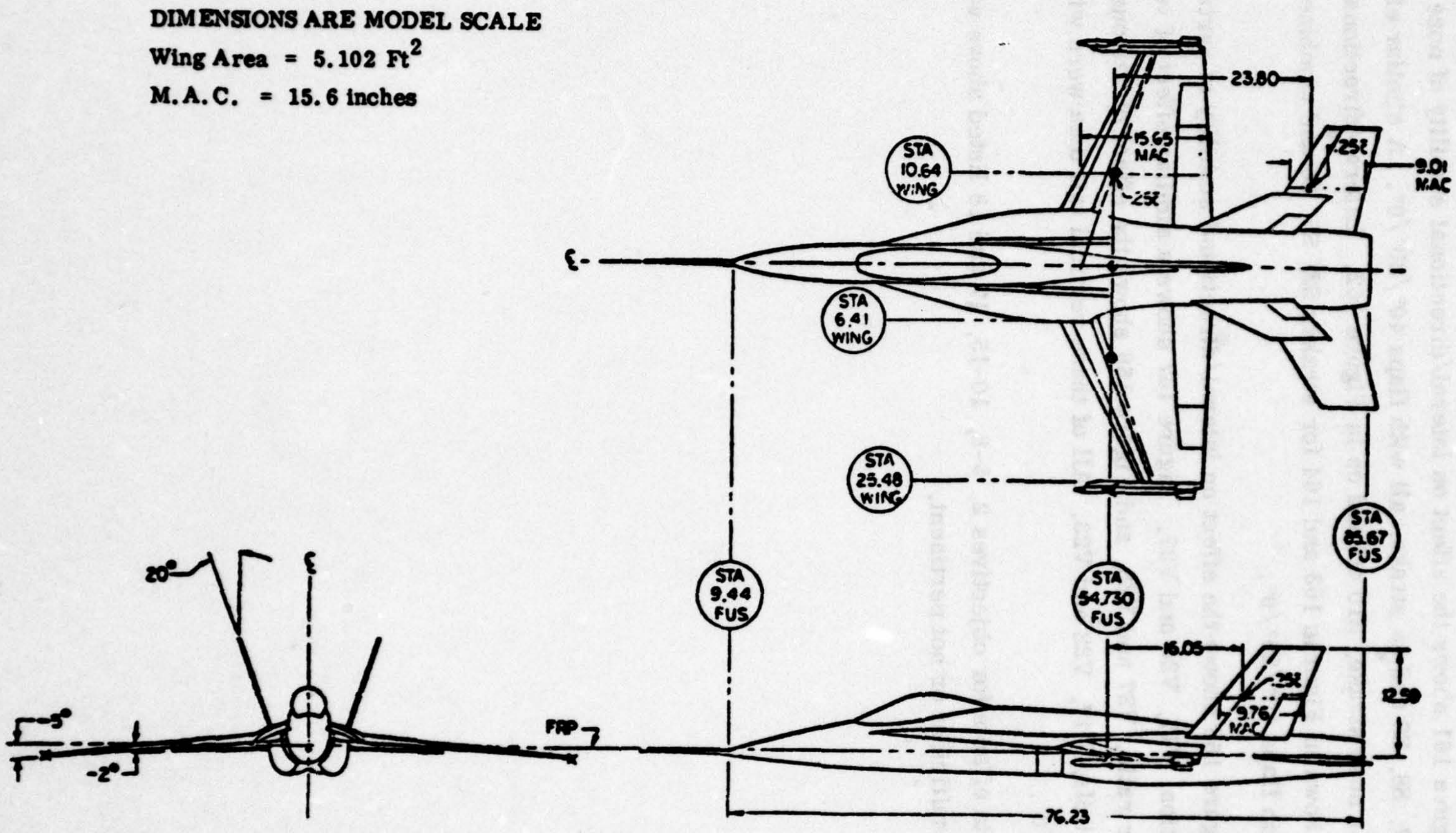


Figure 154. General Three View

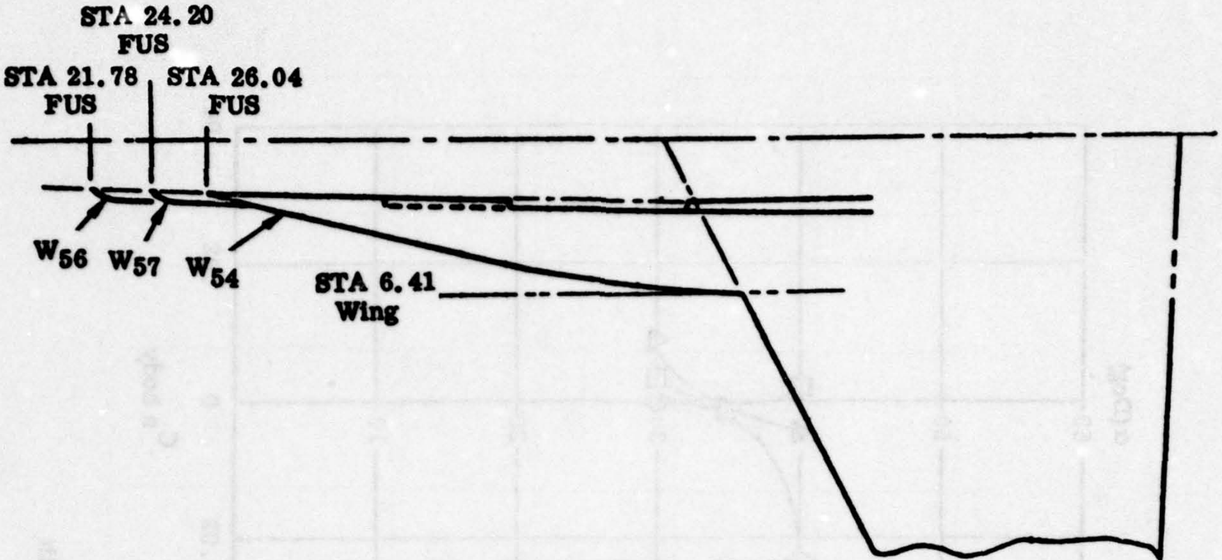


Figure 155. Lex and Strake Planforms

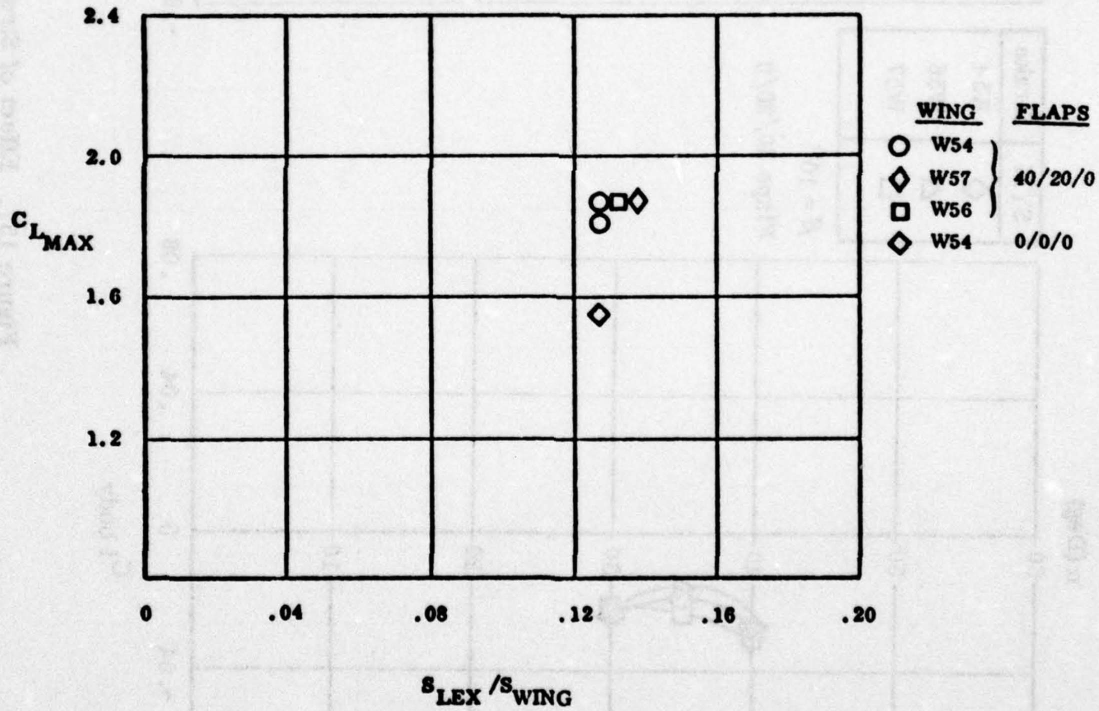


Figure 156. Effect of Strakes on $C_{L_{MAX}}$

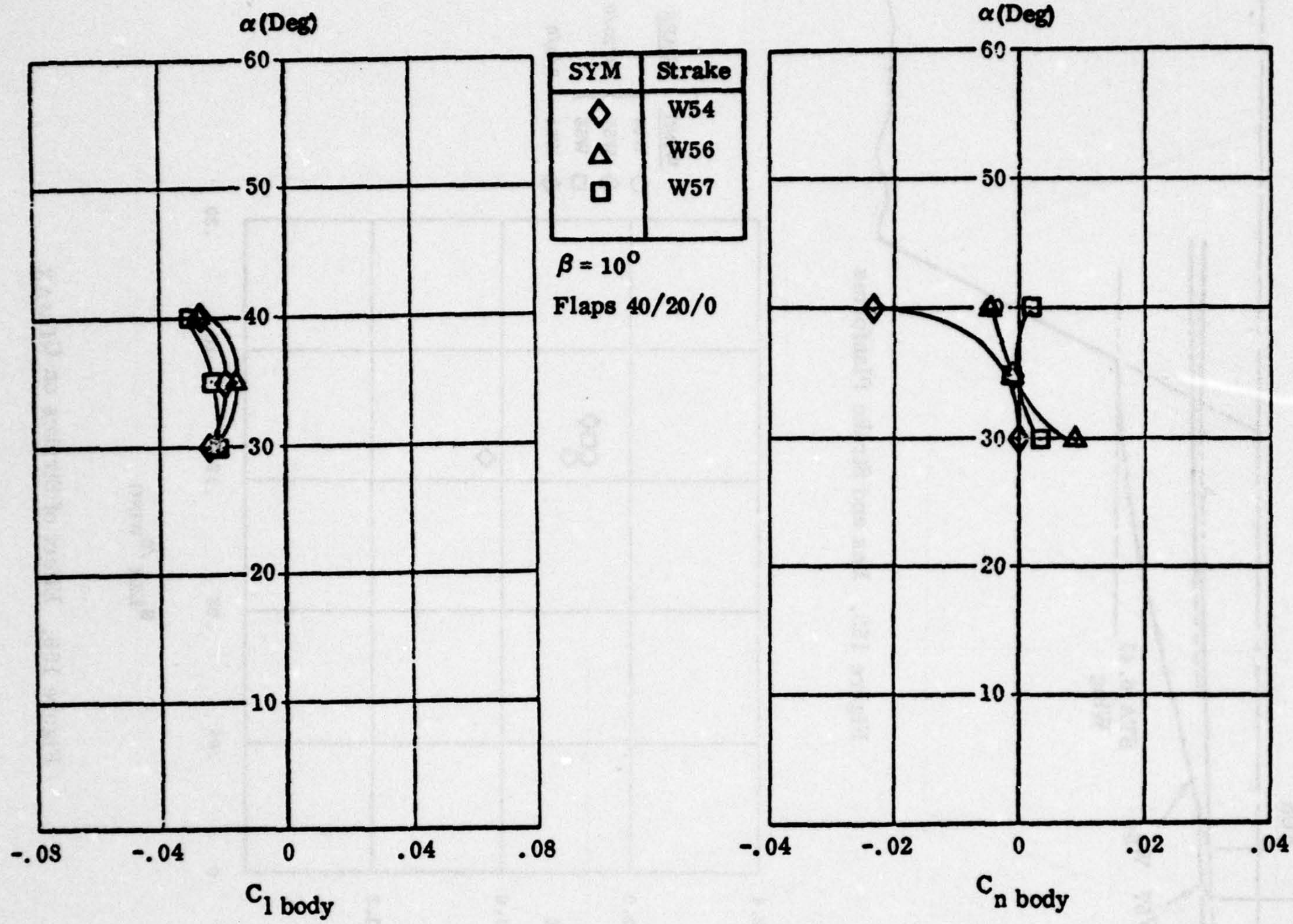


Figure 157. Effect of Strake Length

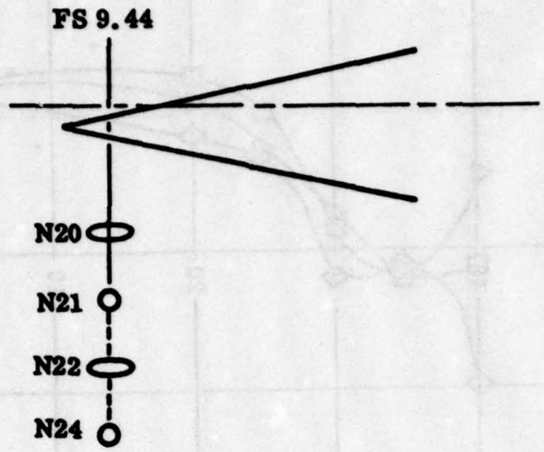


Figure 158. Nose Cross Section

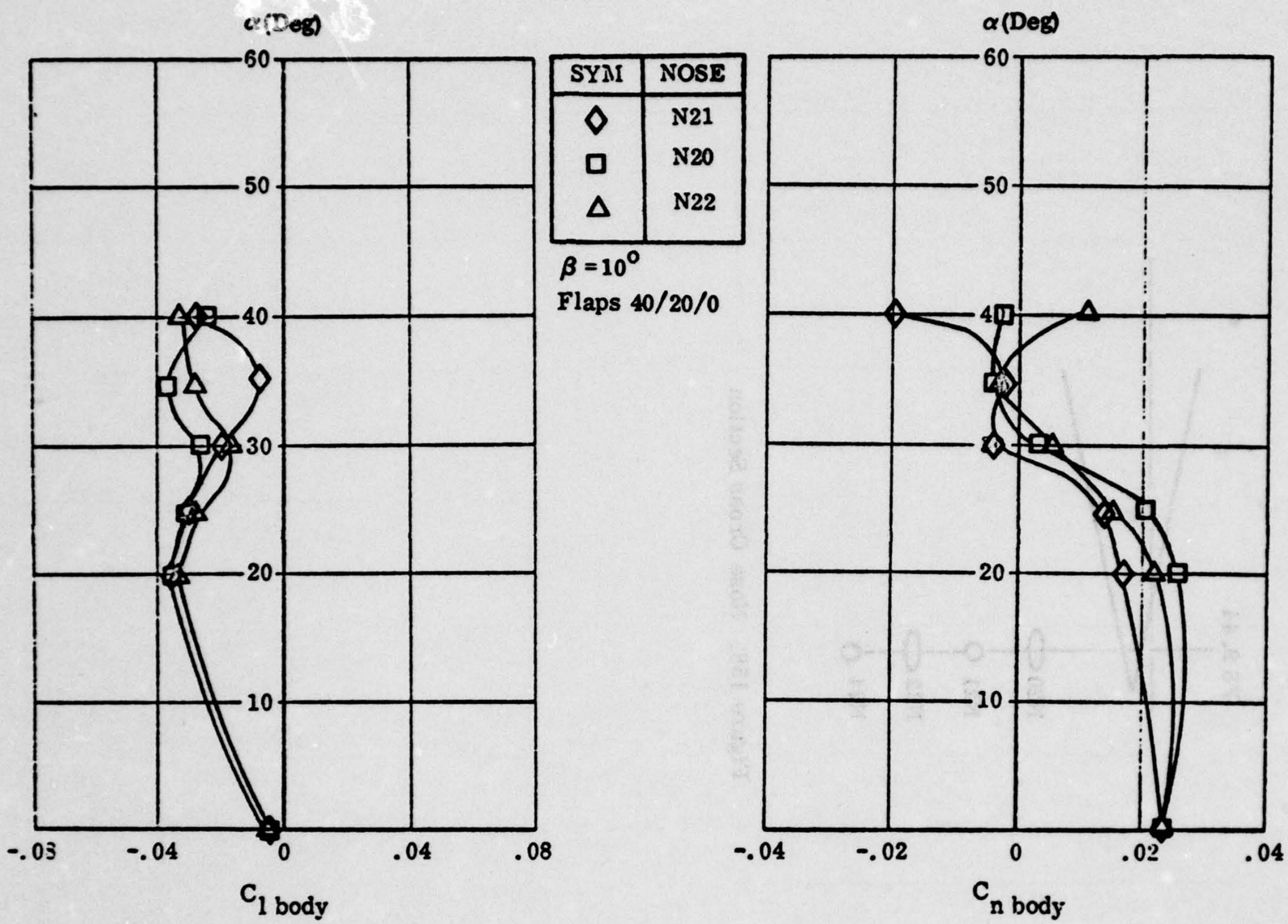
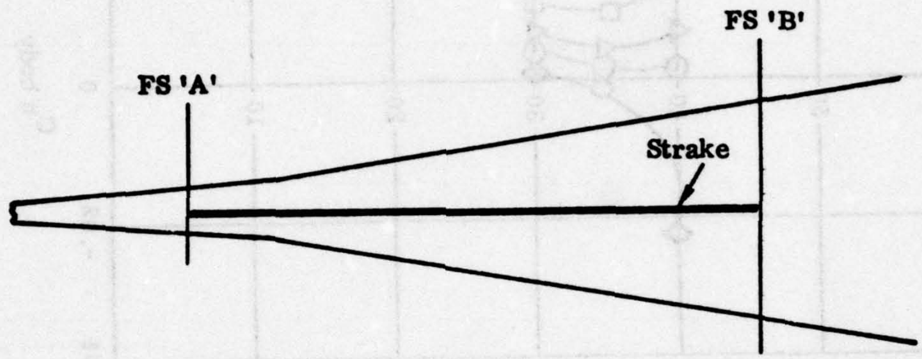


Figure 159. Effect of Nose Configuration



STRAKE	FS 'A'	FS 'B'	COMMENTS	$\Delta C_{L_{MAX}}$
S2	7.44	9.44	Triangular	
S5	10.89	19.36	Triangular (High)	
S6	9.44	19.36	Triangular	
S7	7.44	19.36	Triangular	0.1
S8	7.44	16.94	Triangular	0.06
S9	7.44	14.52	Triangular	0.05
S10	7.44	16.94	Triangular	

Figure 160. Nose Strakes

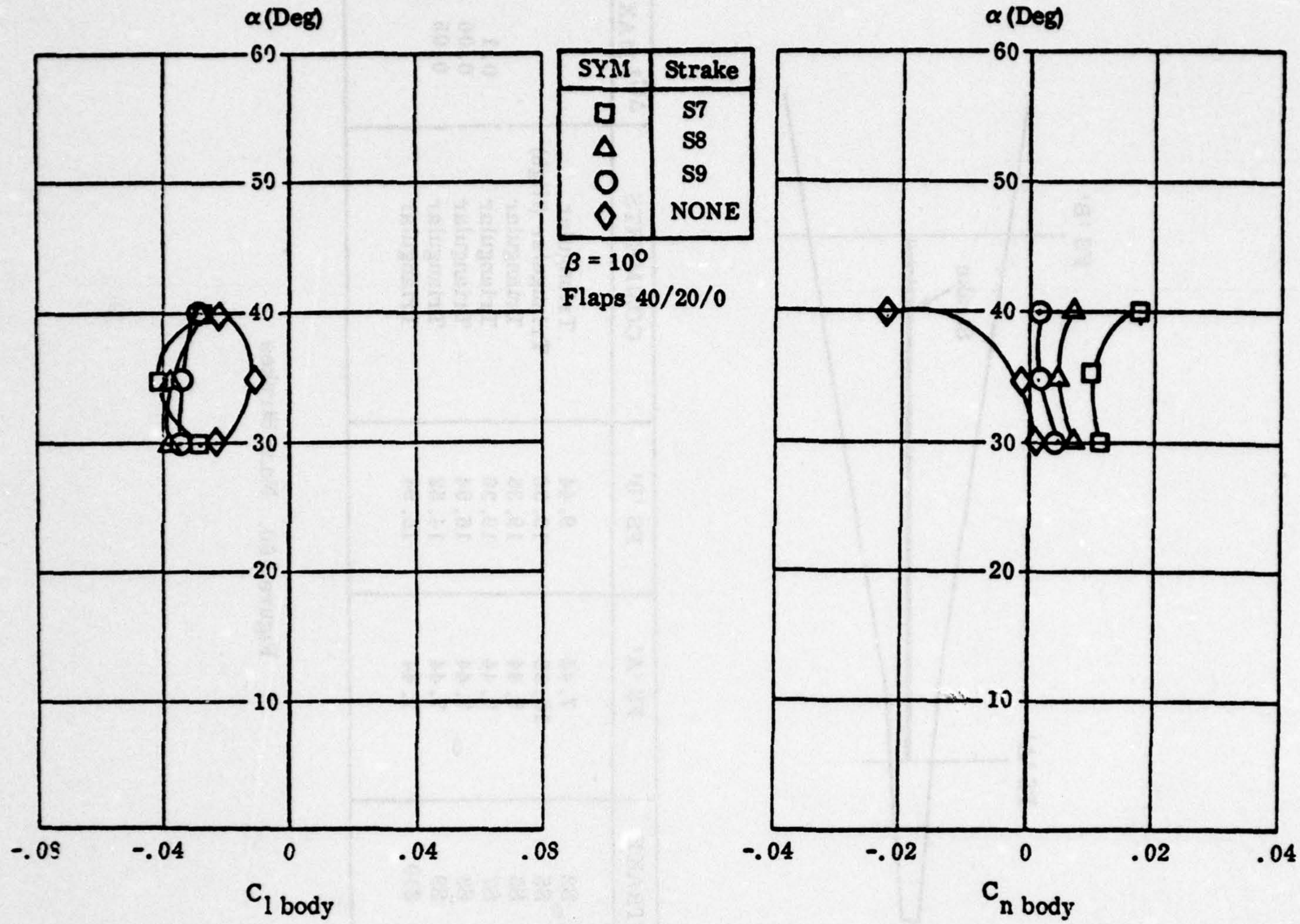


Figure 161. Effect of Nose Strakes on Nose N22

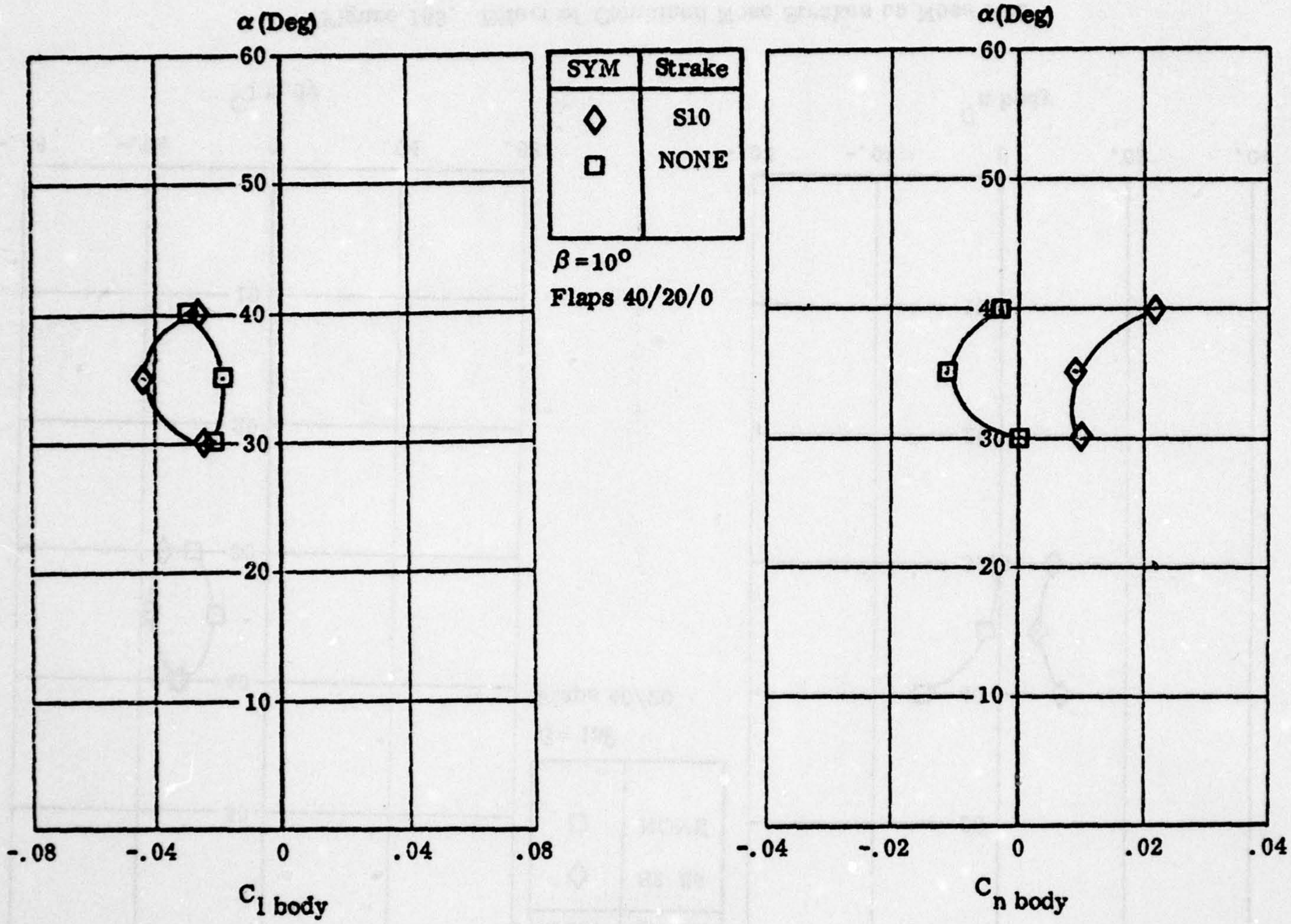


Figure 162. Effect of Nose Strakes on Nose N24

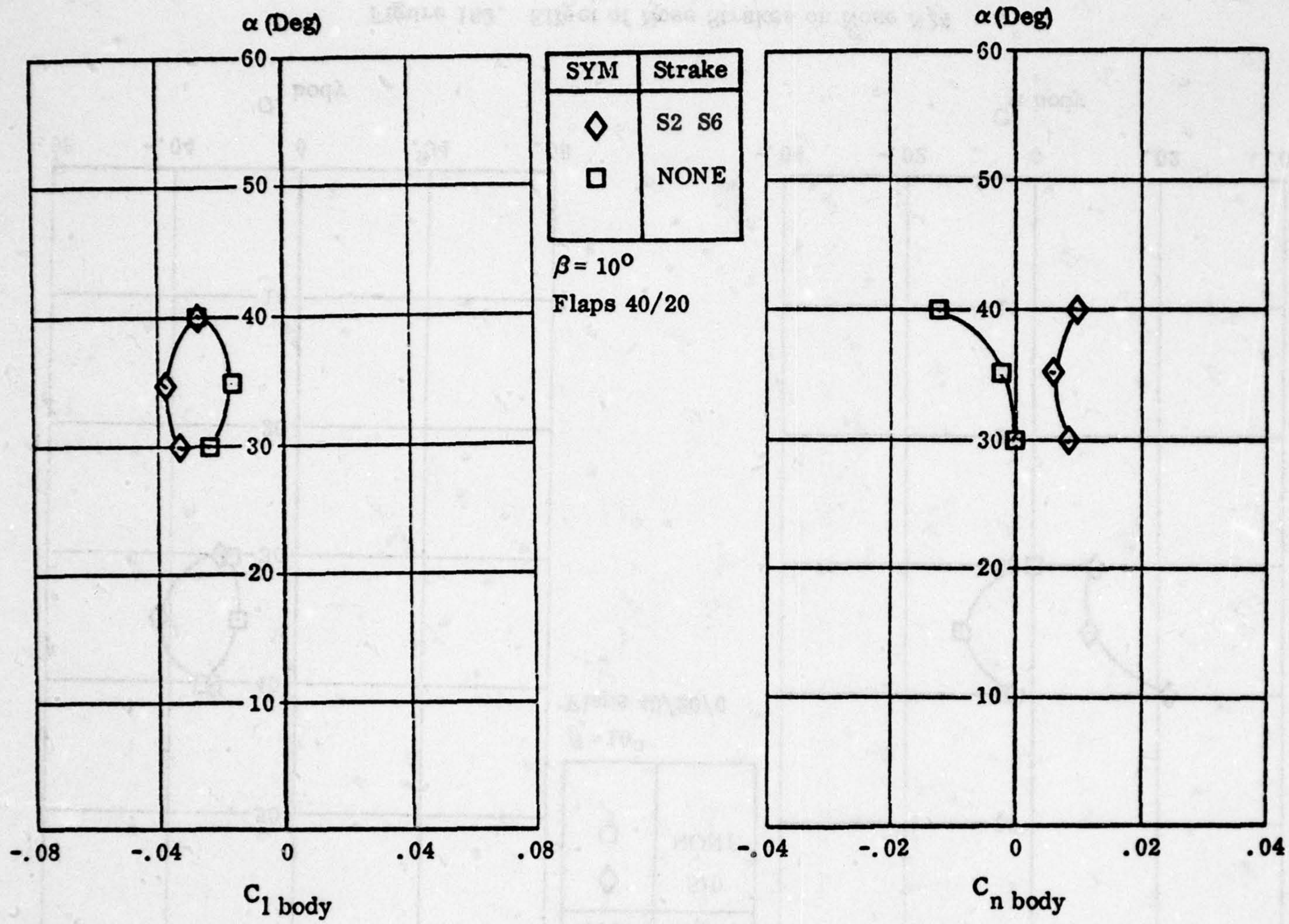


Figure 163. Effect of Combined Nose Strakes on Nose N22

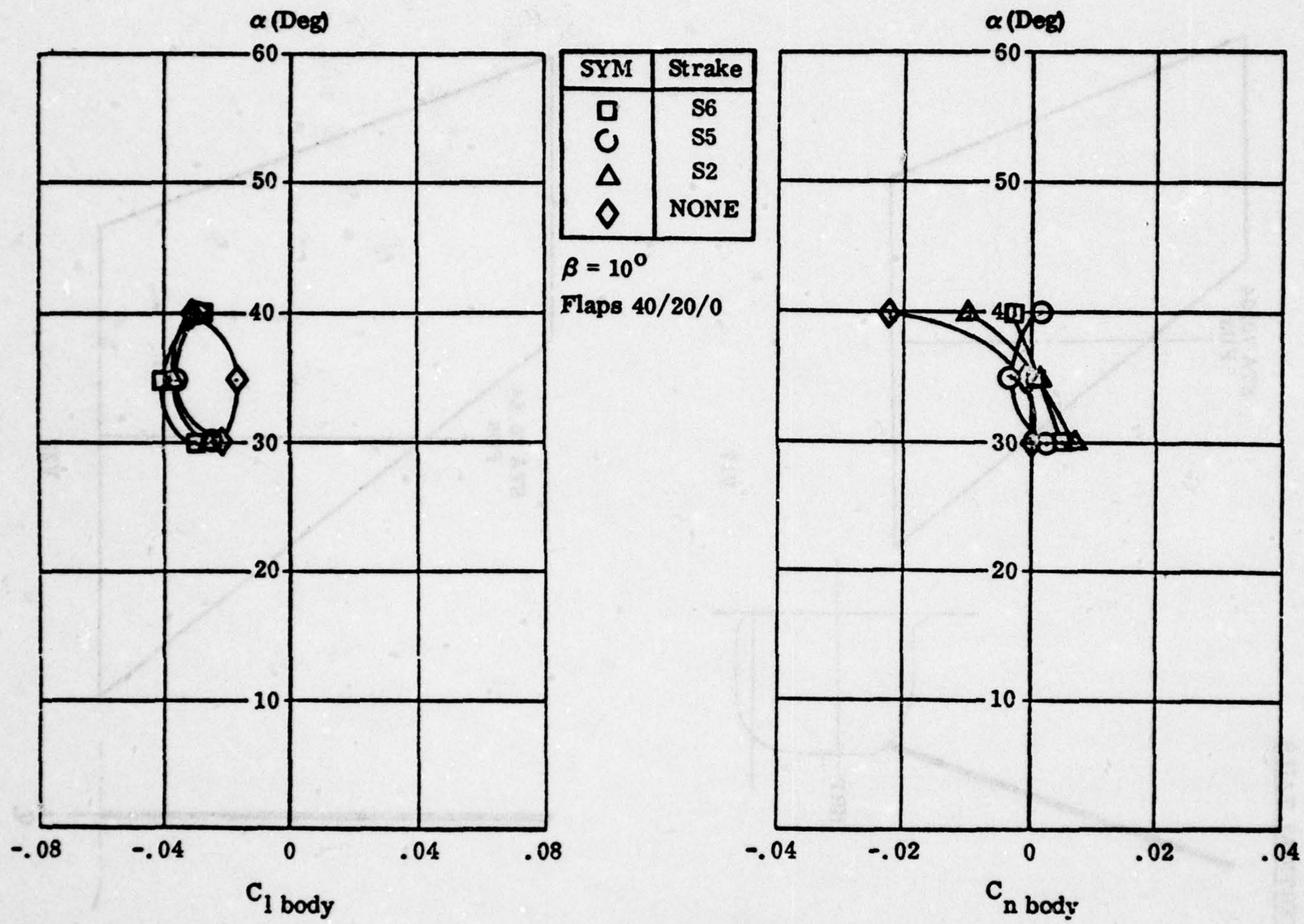


Figure 164. Effect of Strakes on Nose N22

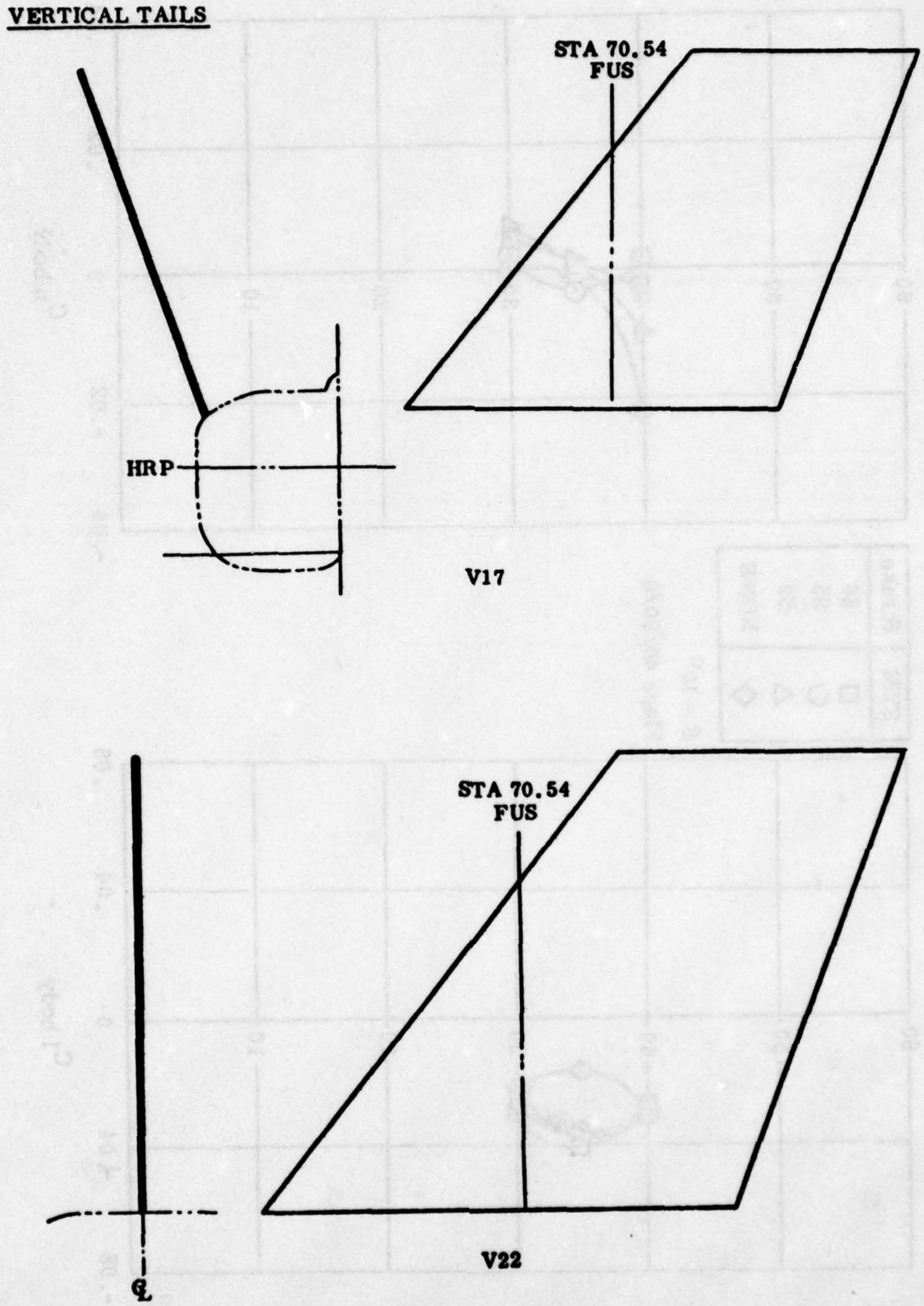
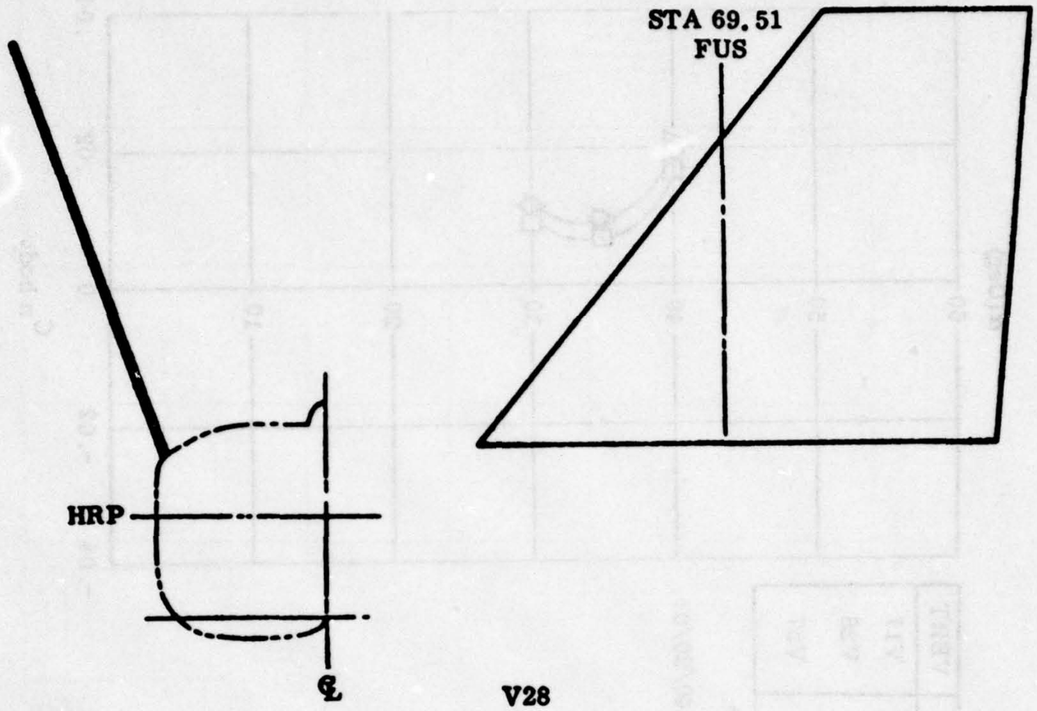


Figure 165. Vertical Tail Configurations



VERT	NOTES
V17	TAPER RATIO 0.6
V22	SINGLE VERTICAL
V23	80% of V17
V26	V17 RIGGED 0.85 inches AFT
V27	V17 RIGGED 0.24 inches AFT
V28	TAPER RATIO 0.4

Figure 165. (Concluded)

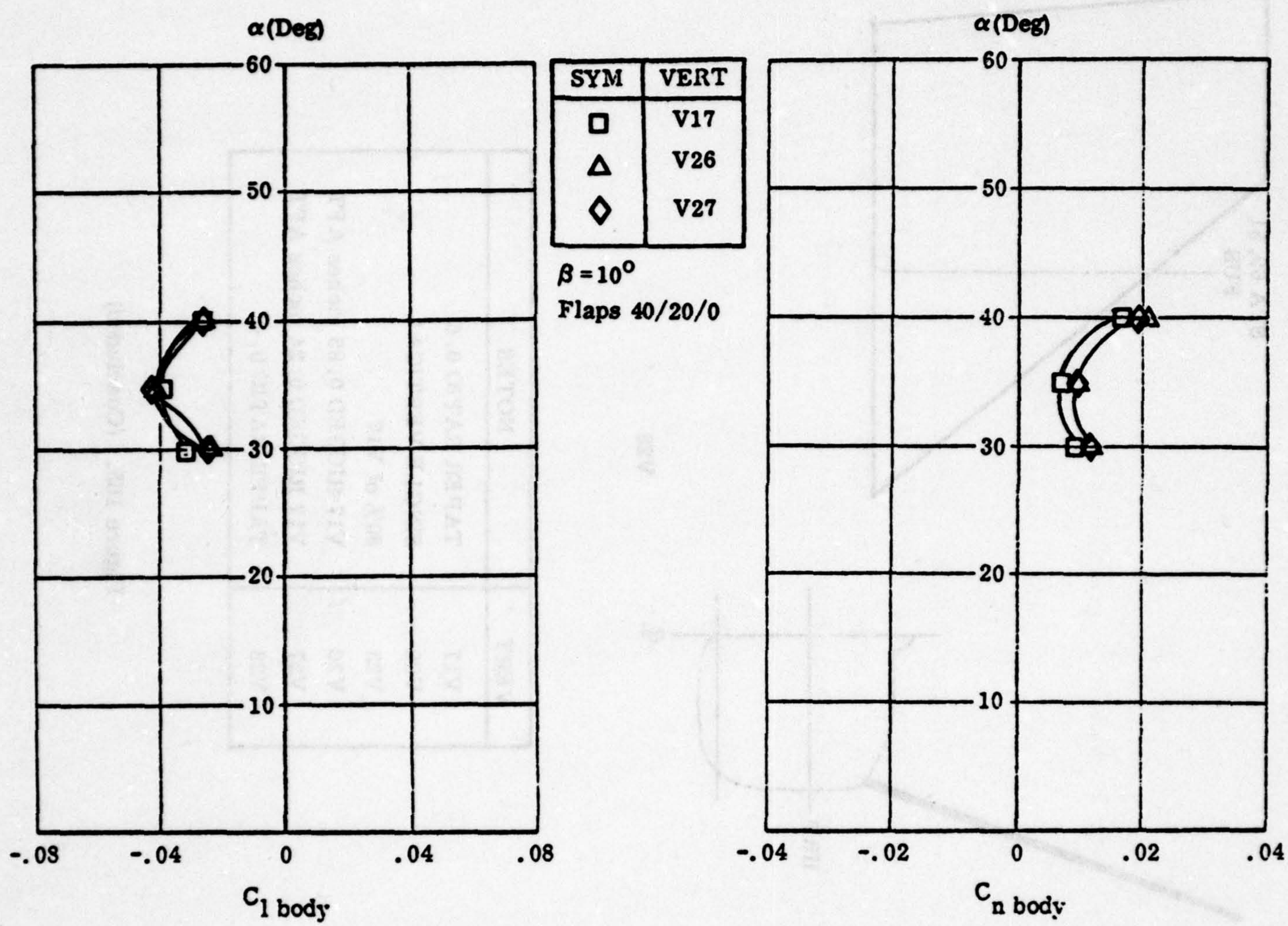


Figure 166. Effect of Vertical Tail Location

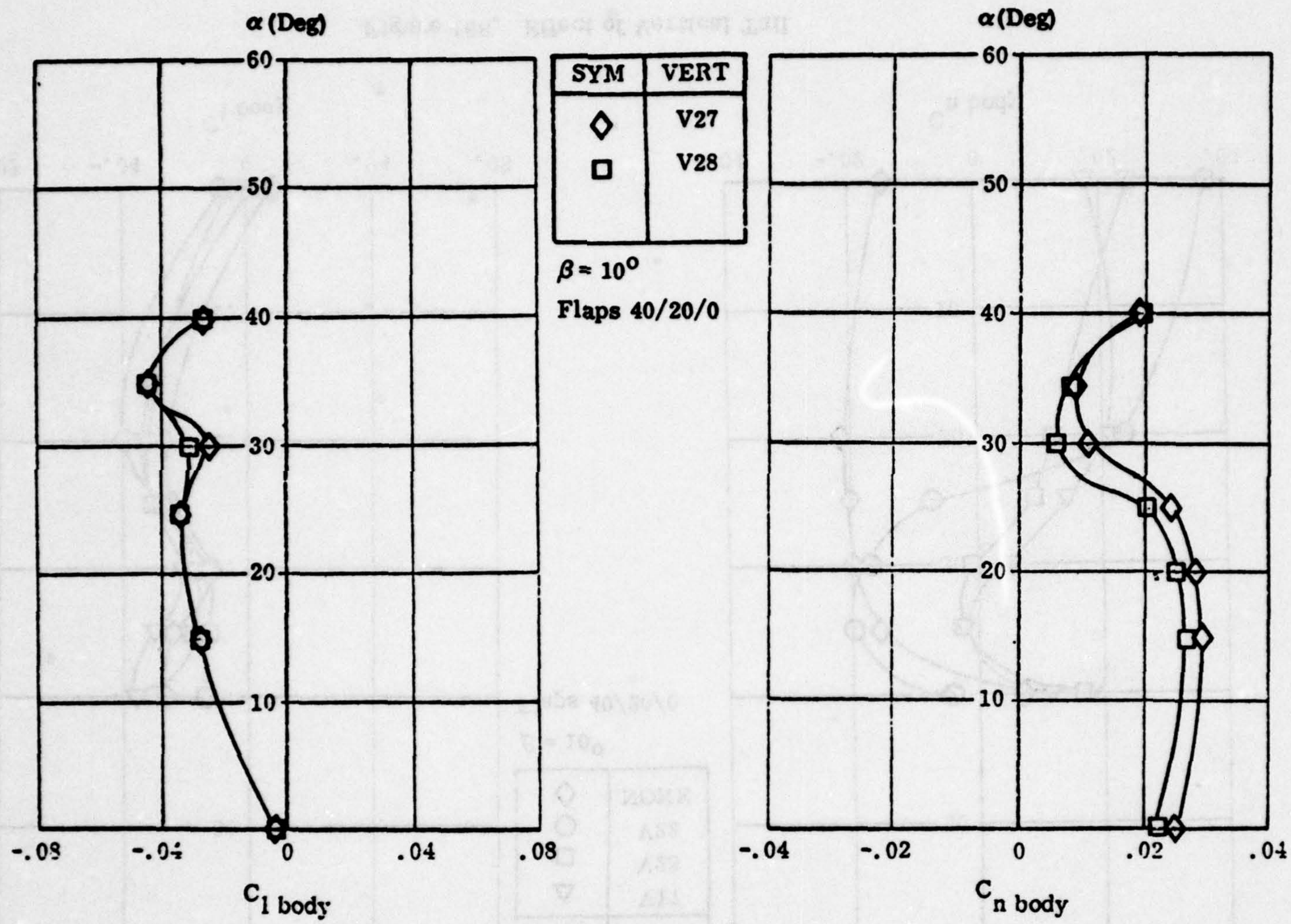


Figure 167. Effect of Vertical Tail

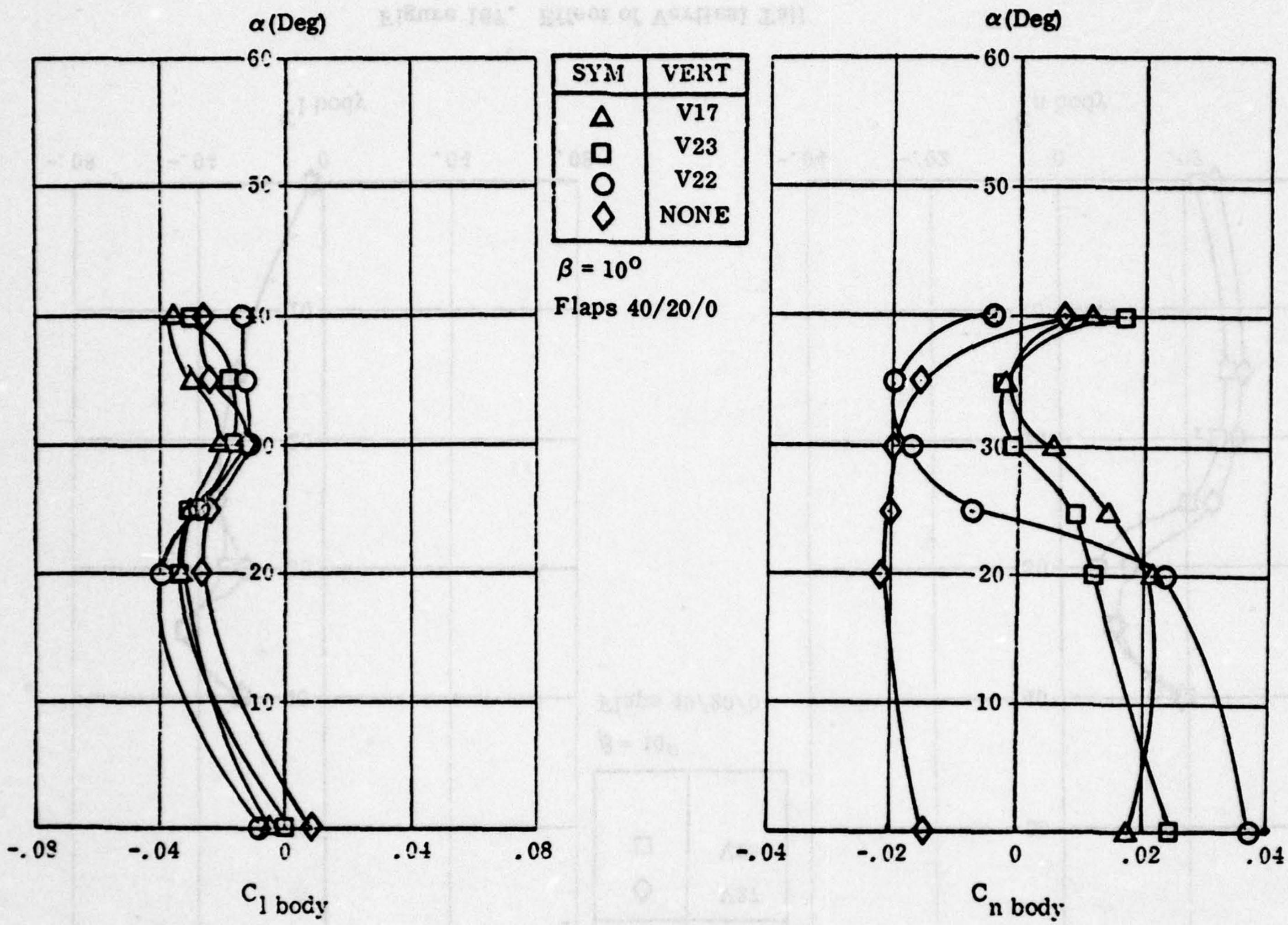


Figure 168. Effect of Vertical Tail

AIRCRAFT **YF-17** REFERENCE **31**

TEST REPORT

NOR 72-188 Data Report of a Low Speed Wind Tunnel Test of a 0.121 Scale Advanced Fighter, First Model, Second Low Speed Test

A.D. Crandall

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of an existing 0.121 scale preliminary model of a P600 airplane configuration. The test was a low speed aerodynamic investigation to test configuration variations. This test program was conducted during the period from 7 through 25 August 1972.

Primary purposes of the test were to determine:

1. Effect of slot geometry
2. Comparison of nose strakes
3. Comparison of wing leading edge flap deflection angle and segmentation
4. Effect of wing trailing edge flap deflection angle
5. Empennage build-up
6. Horizontal tail effectiveness
7. Comparison of horizontal tail planforms
8. Comparison of vertical tail planforms
9. Aileron and rolling tail effectiveness
10. Effect of speedbrakes
11. Lateral-Directional characteristics in pitch and sideslip

TEST
CONDITIONS

Mach No. = 0.22

R.N./Foot = 1.5×10^6

A.O.A. Range = -6° to 40°

Sideslip Range = -10° to 25°

AIRCRAFT
CONFIGURATION

A basic model three view is shown in Figure 169.

CONFIGURATION
CHANGES

Sketches of nose strake configuration changes applicable to this study are shown in Figure 170.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 171 shows the effect on lateral/directional stability of nose strakes S15, S16 and S17 with flaps $40^\circ/20^\circ/0^\circ$.

Data effects for other objectives listed above was either insufficient or not considered pertinent.

DIMENSIONS ARE MODEL SCALE

Wing Area = 5.102 Ft^2
M. A. C. = 15.6 inches

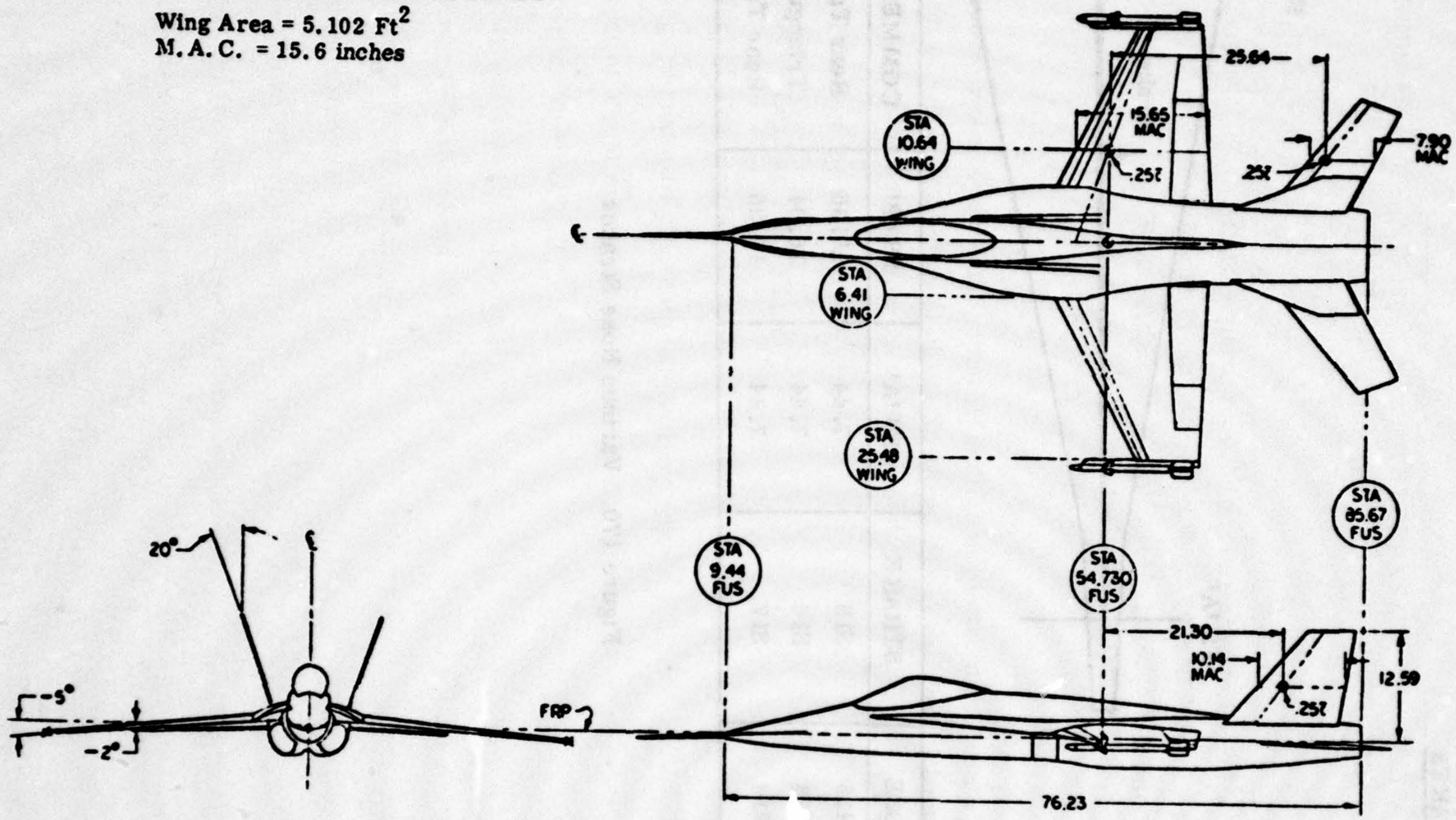
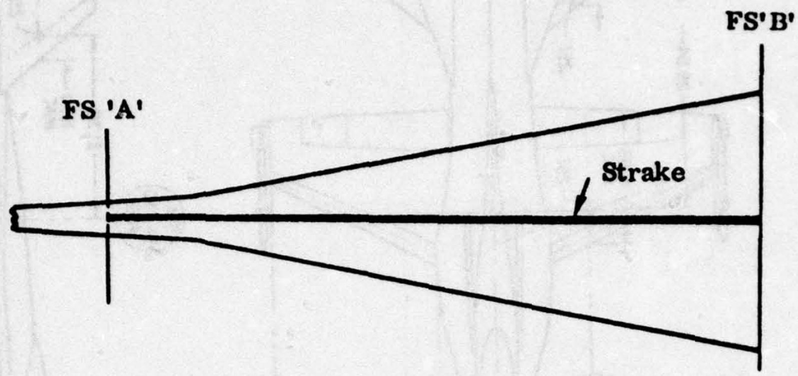


Figure 169. General Three View

NOSE STRAKES



NOSE	STRAKE	FS 'A'	FS 'B'	COMMENTS
N18	S15	7.44	19.36	Rear Taper
N18	S16	7.44	16.94	Triangular
N18	S17	7.44	19.36	Rear Taper

Figure 170. Various Nose Strakes

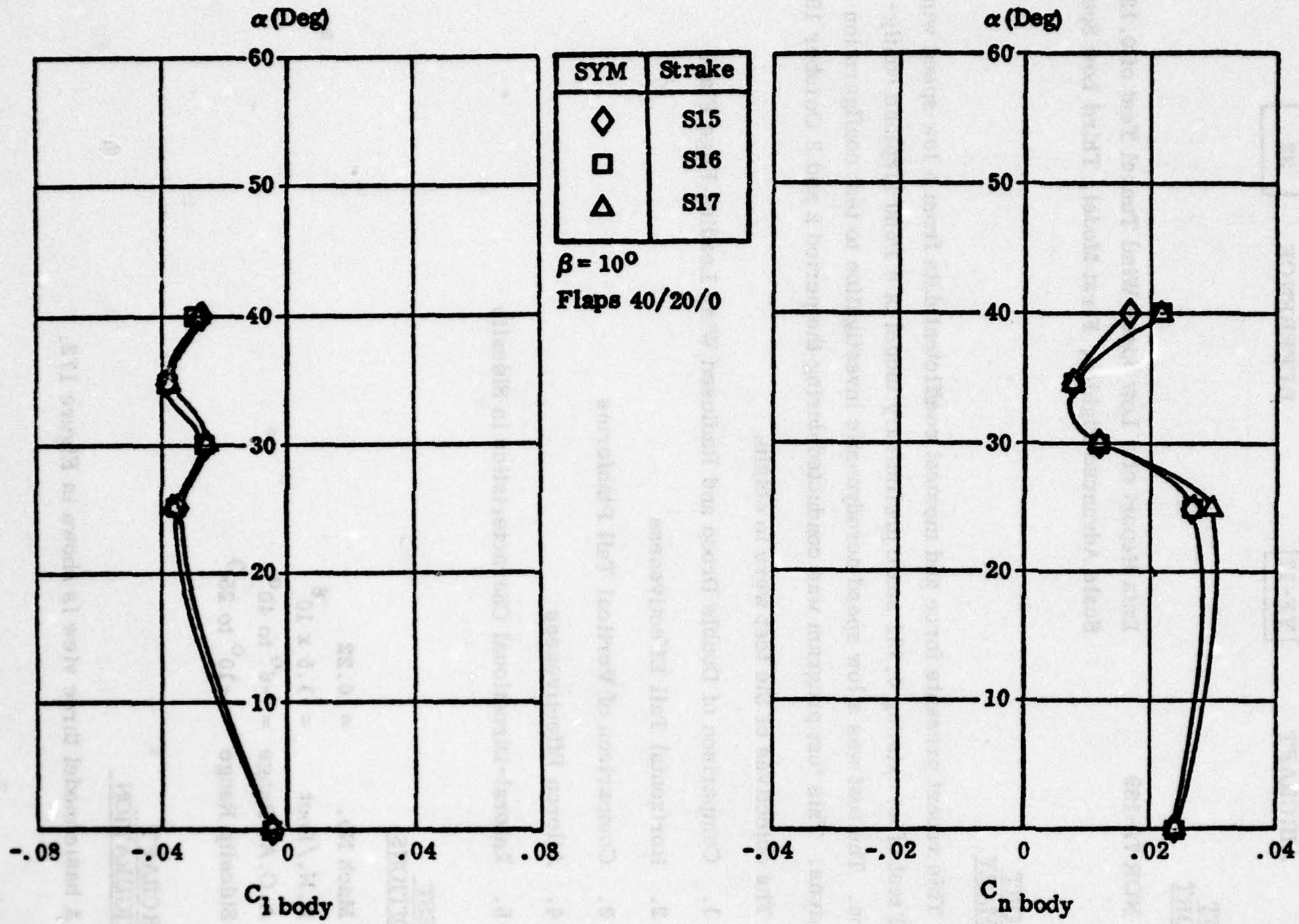


Figure 171. Effect of Nose Strakes

AIRCRAFT **YF-17** REFERENCE **32**

TEST REPORT

NOR 72-189 Data Report of a Low Speed Wind Tunnel Test of 0.121 Scale Advanced Fighter, First Model, Third Low Speed Test

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of an existing 0.121 scale preliminary model of a P600 airplane configuration. The test was a low speed aerodynamic investigation to test configuration variations. This test program was conducted during the period 2 and 3 October 1972.

The objectives of the test were to obtain:

1. Comparison of Double Droop and Radiused Wing Leading Edge Flaps
2. Horizontal Tail Effectiveness
3. Comparison of Vertical Tail Planforms
4. Aileron Effectiveness
5. Lateral-Directional Characteristics in Sideslip

TEST CONDITIONS

Mach No. = 0.22

R.N./Foot = 1.5×10^6

A.O.A. Range = -6° to 40°

Sideslip Range = -10° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 172.

CONFIGURATION CHANGES

Sketches of vertical tail and dorsal fin configuration changes applicable to this study are shown in Figure 173.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 174 shows the effect on lateral/directional stability of vertical tails V31, V32 and V33, the latter two including a dorsal fin. Vertical tail location change represented by V30 and V31 showed no effect on the pitch data.

Data effects for objectives 1, 2, 4 and 5 listed above were either insufficient or not considered pertinent.

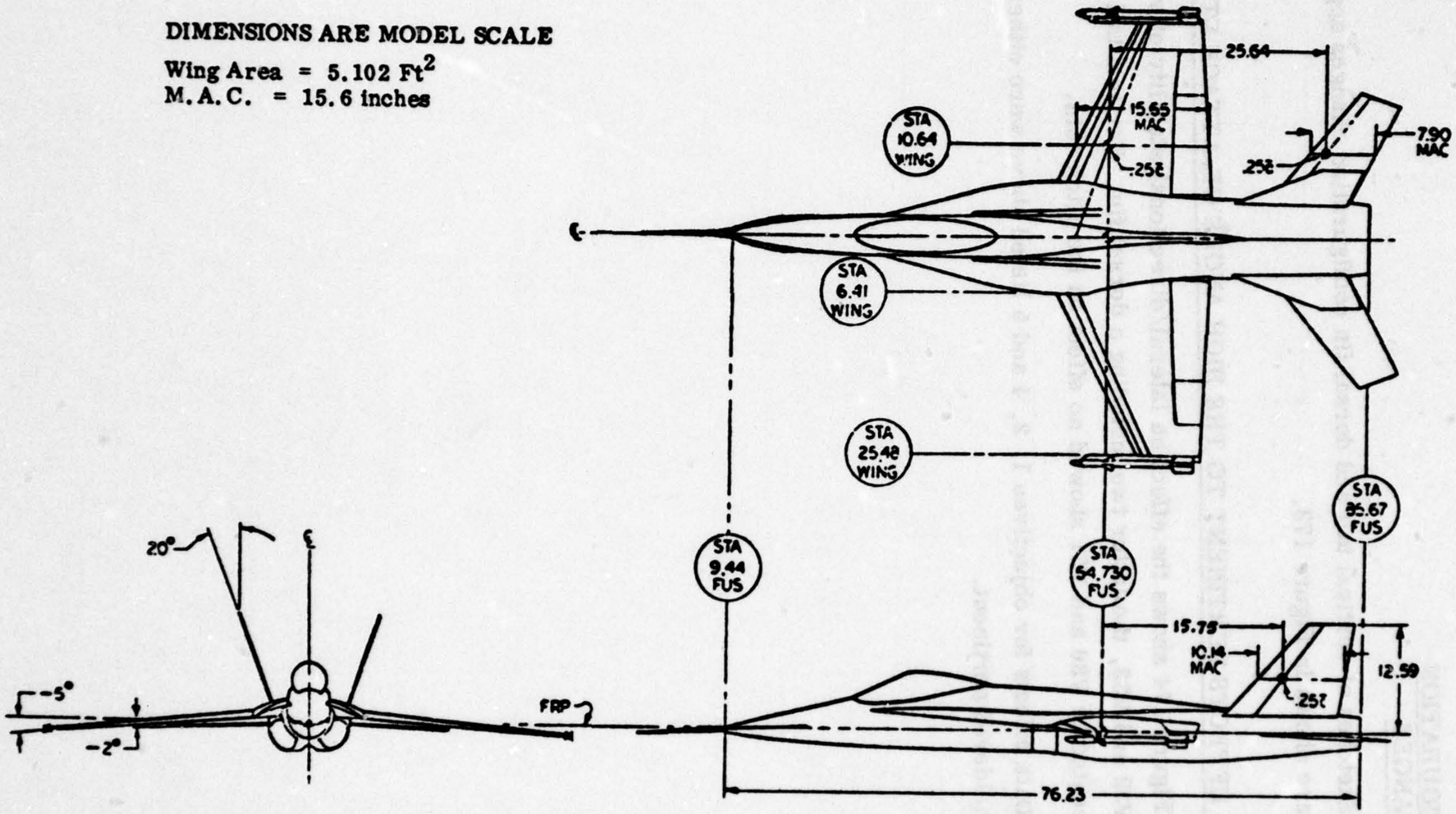
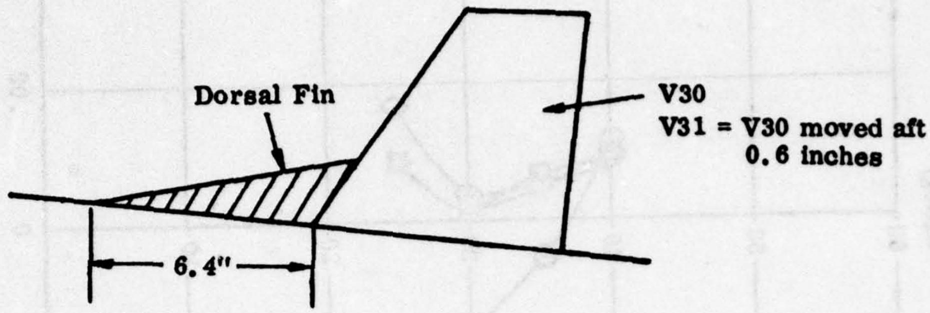


Figure 172. General Three View

VERTICAL TAILS



VERT	CONTOUR
V32	Slab
V33	Cambered

Figure 173. Vertical Tail and Dorsal Fin

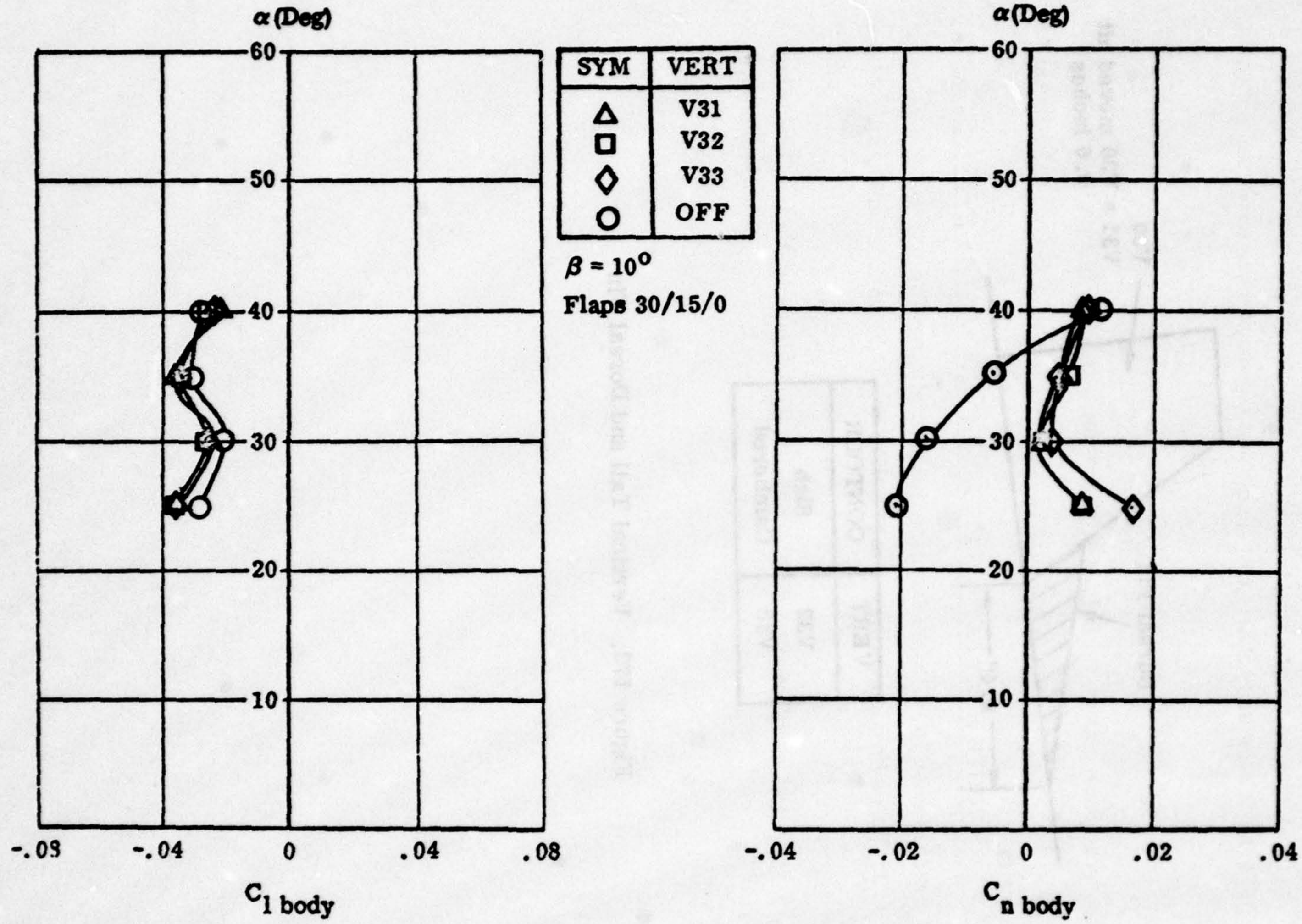


Figure 174. Effect of Vertical Tail and Dorsal Fin

AIRCRAFT **YF-17** REFERENCE **33**

TEST REPORT

NOR 73-010 — Data Report of a 0.08 scale Northrop YF-17 Force Model First Low Speed Wind Tunnel Test

W.P. Rehm — Volume I, III

REPORT SUMMARY

This report presents force and moment coefficient plotted data from a low speed wind tunnel test of a 0.08 scale model of the Northrop YF-17 airplane. This program was conducted during the period from 25 to 29 September 1972.

The objectives of the test were to obtain:

1. Effect of Leading Edge Flaps
2. Effect of Trailing Edge Flaps
3. Effect of Inboard Pylon With 600 Gallon Tank
4. Effect of Tip Missiles
5. Effect of Vertical Tail
6. Horizontal Tail Effectiveness
7. Aileron Effectiveness
8. Rolling Tail Effectiveness
9. Rudder Effectiveness
10. Speedbrake Effectiveness
11. Lateral-Directional Characteristics in Sideslip
12. High Attitude Characteristics

TEST CONDITIONS

Mach No. = 0.2

R.N./Foot = 1.4×10^6

A.O.A. Range = -6° to 40°

Sideslip Range = -10° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 175. All runs with wing W2.

CONFIGURATION CHANGES

None

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 176 shows the effect on $C_{L_{MAX}}$ of flap deflection with wing W2.

Figures 177 and 178 show the effect on lateral/directional stability of nose boom i_1, nose boom and strake i_1, + s_1, and vertical tail V2, all with a flap setting of $30^\circ/15^\circ/0^\circ$.

Data effects for objectives 2 through 4 and 6 through 10 listed above was either insufficient or not considered pertinent.

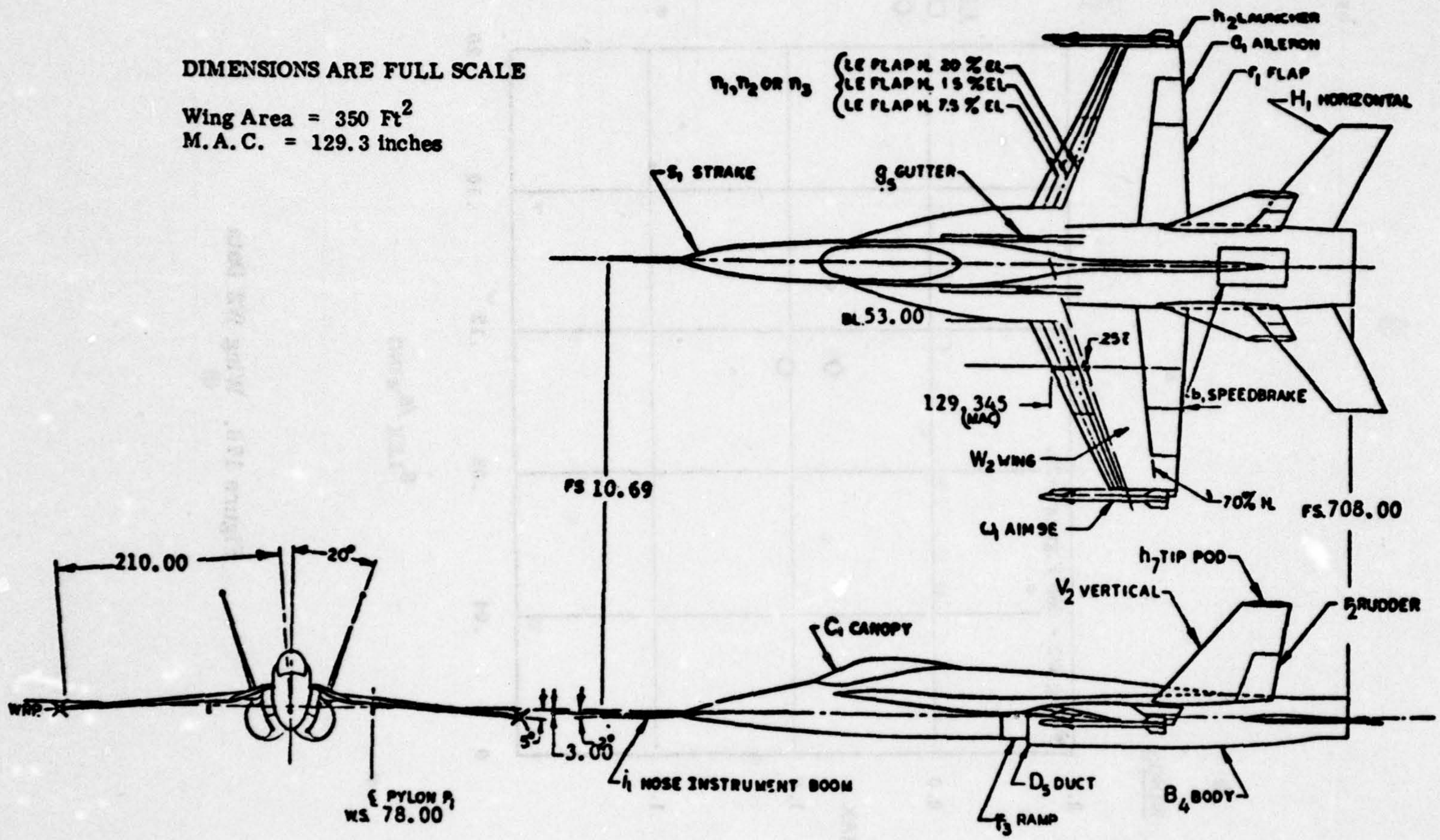


Figure 175. General Three View

WINGS

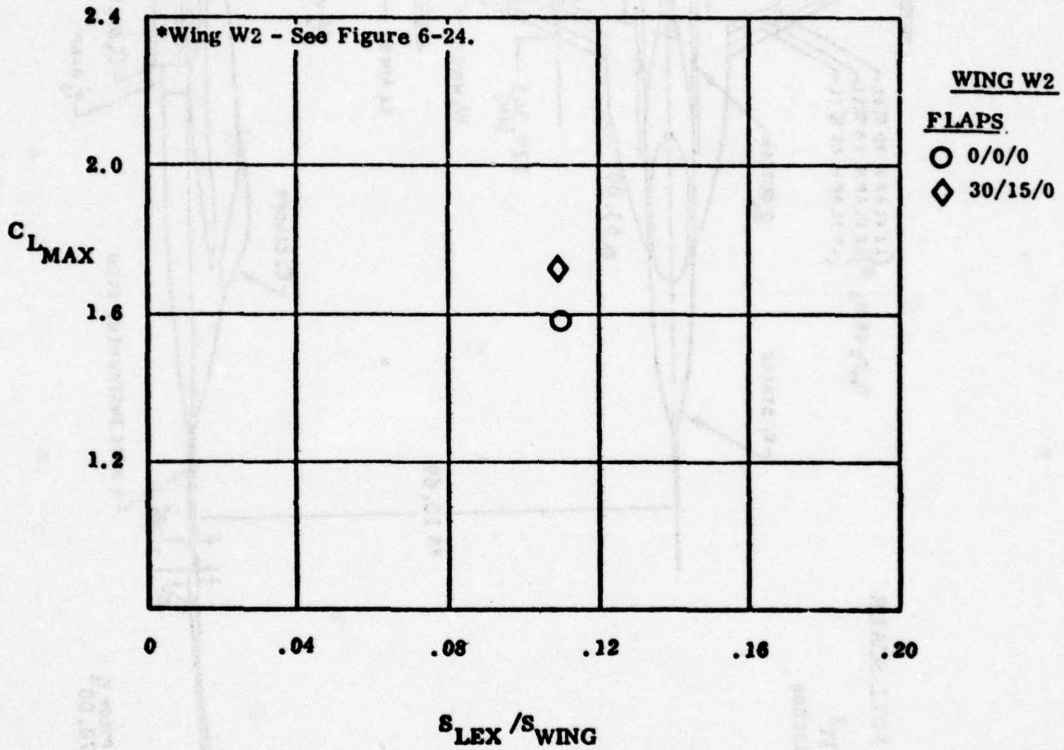


Figure 176. Wing W2 Data

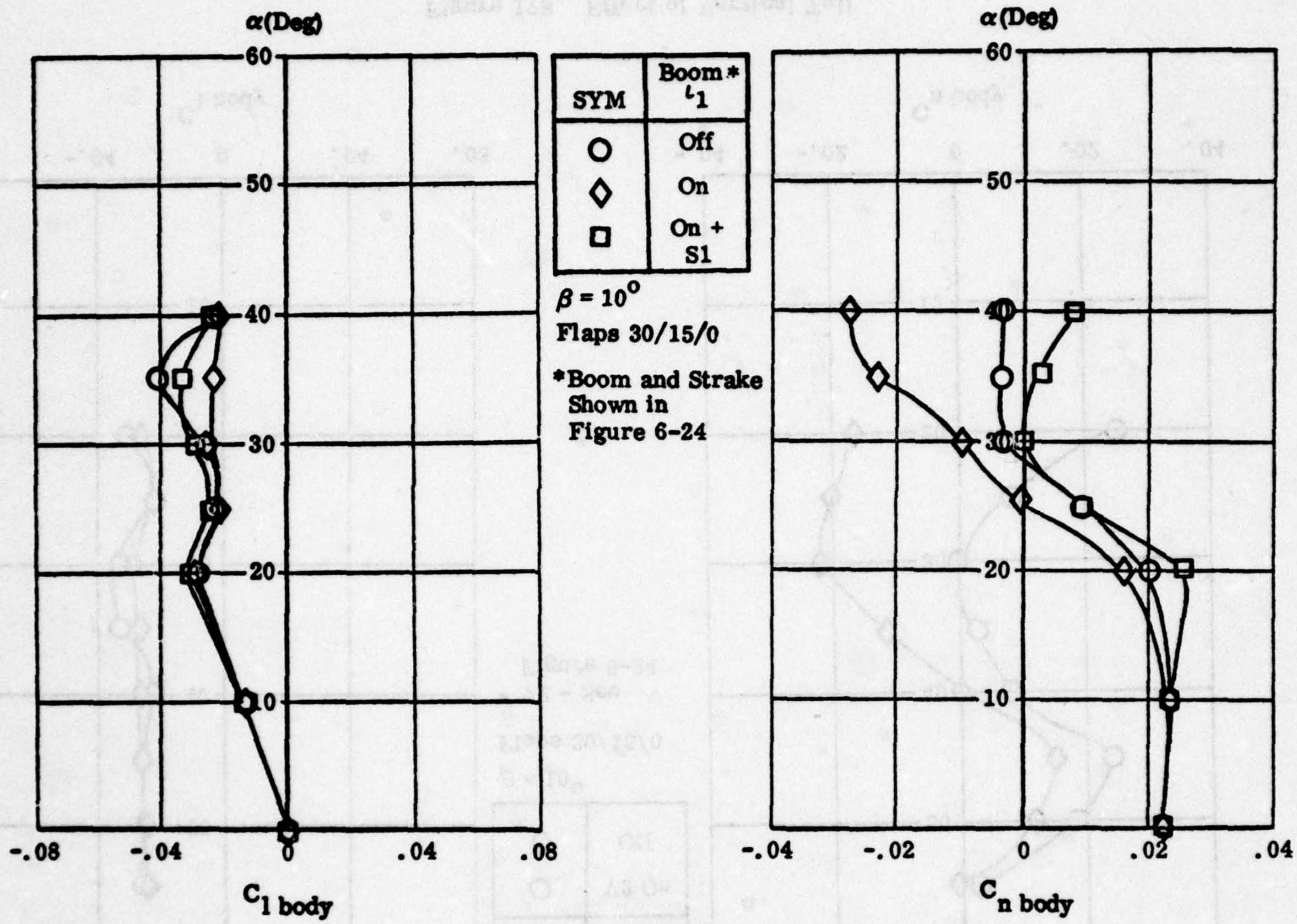


Figure 177. Effect of Nose Boom and Nose Strake

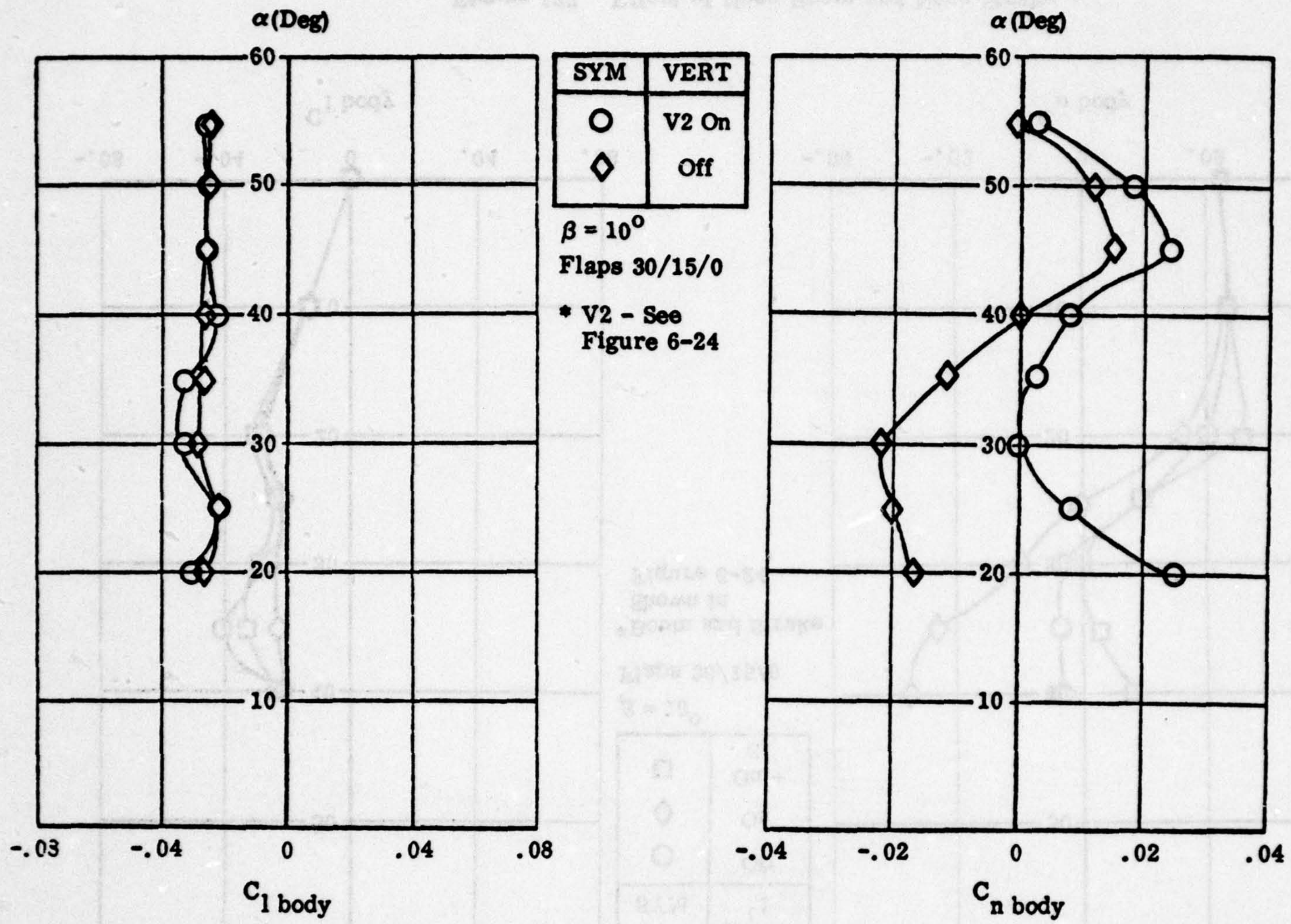


Figure 178. Effect of Vertical Tail

AIRCRAFT **YF-17** REFERENCE **34**

TEST REPORT

NOR 73-044 — Data Report of a 0.08 Scale Northrop YF-17 Force Model - Second Low Speed Wind Tunnel Test

L.H. Brown, Jr. Volume I, II

REPORT SUMMARY

This report documents the results from a low speed wind tunnel test of a 0.08 scale model of the Northrop YF-17 airplane. The test program was conducted during the period 29 January through 8 February 1973.

The primary objective of the test program was to evaluate the basic low speed aerodynamic characteristics of the YF-17 airplane with the 20% hinge line single-droop leading edge flap configuration. The items investigated were as follows:

1. Horizontal Tail Effectiveness
2. Aileron Effectiveness
3. Rudder Effectiveness (80% Hinge Line)
4. Leading Edge Flap Effectiveness
5. Trailing Edge Flap Effectiveness
6. Rolling Horizontal Tail Effectiveness
7. Effect of Nose Strake Configuration
8. Effect of Landing Gear Configuration

A secondary objective of these tests was to obtain additional longitudinal and lateral-directional stability characteristics at high attitudes.

TEST CONDITIONS

Mach No. = 0.2

R.N./Foot = 1.4×10^6

A.O.A. Range = -6° to 40°

Sideslip Range = -10° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 179. (All runs with wing W2.)

CONFIGURATION CHANGES

Sketches of nose strake configuration changes applicable to this study are shown in Figure 180.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 181 shows the effect on lateral/directional stability of nose strakes S1, S5, S6 and S7 with a flap setting of $25^{o}/0^{o}/0^{o}$. These strakes showed no effect in the pitch data.

Data effects for the other objective outlined above was either insufficient or not considered pertinent.

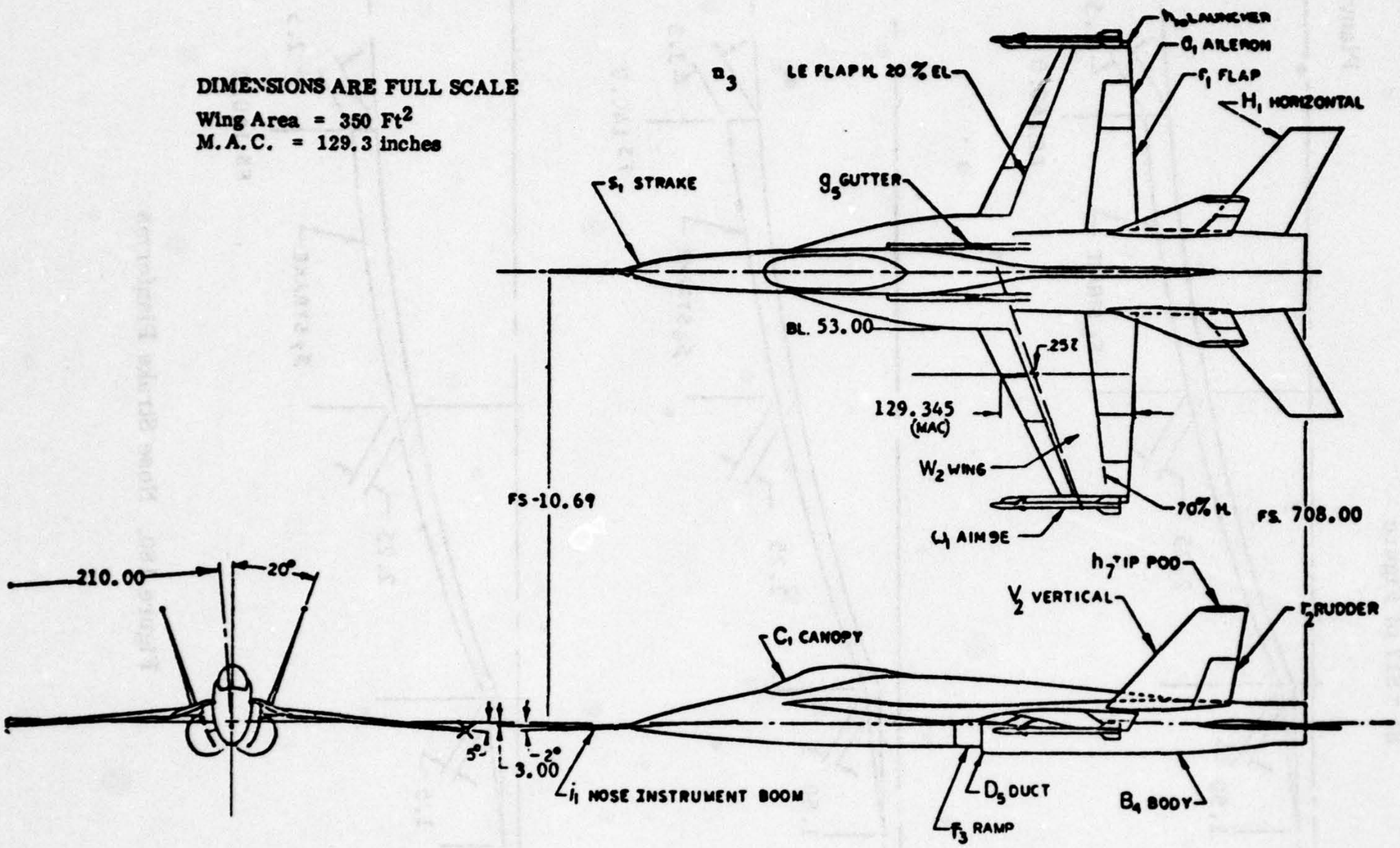


Figure 179. General Three View

S1 = S17 of Figure

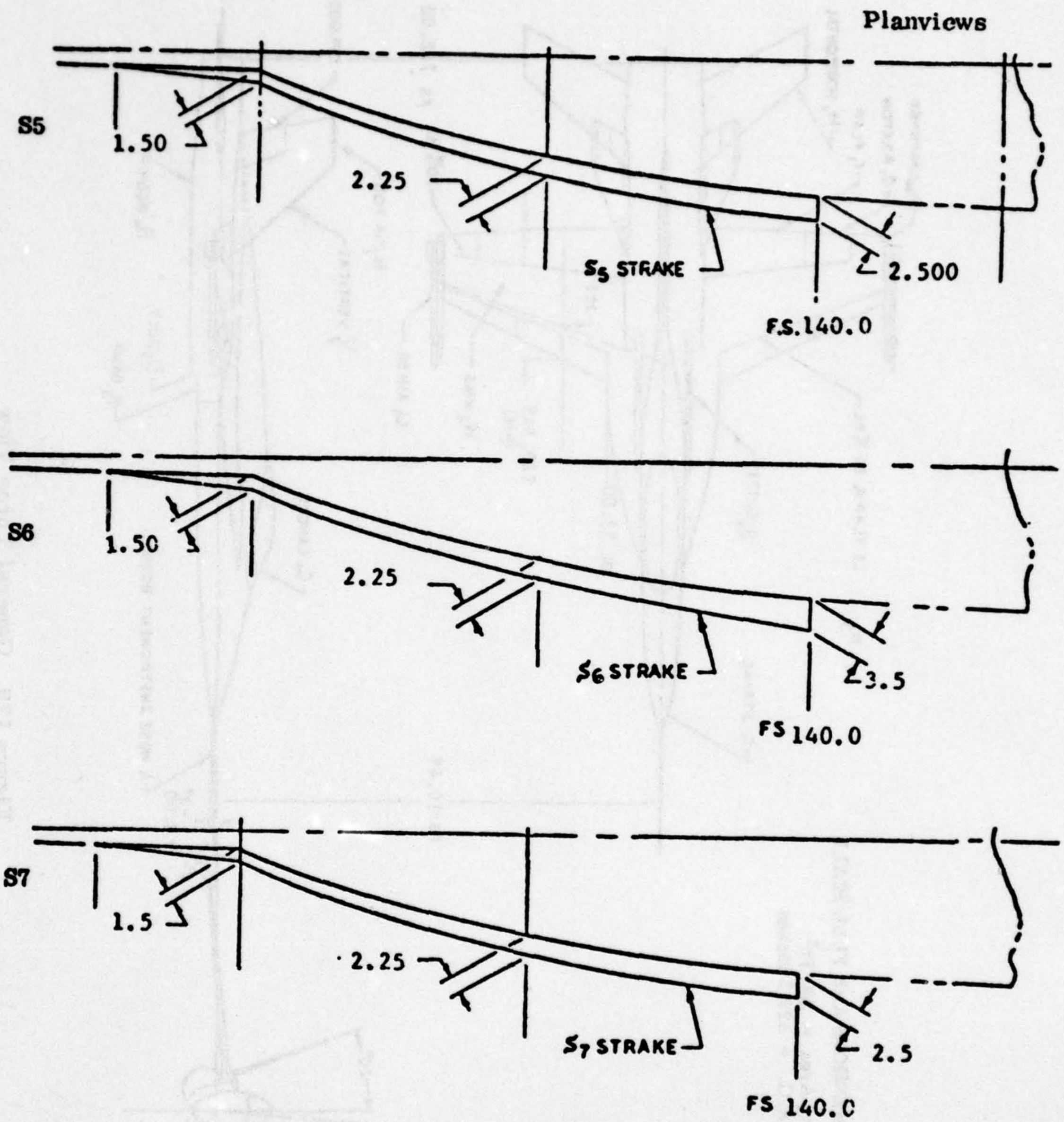


Figure 180. Nose Strake Planforms

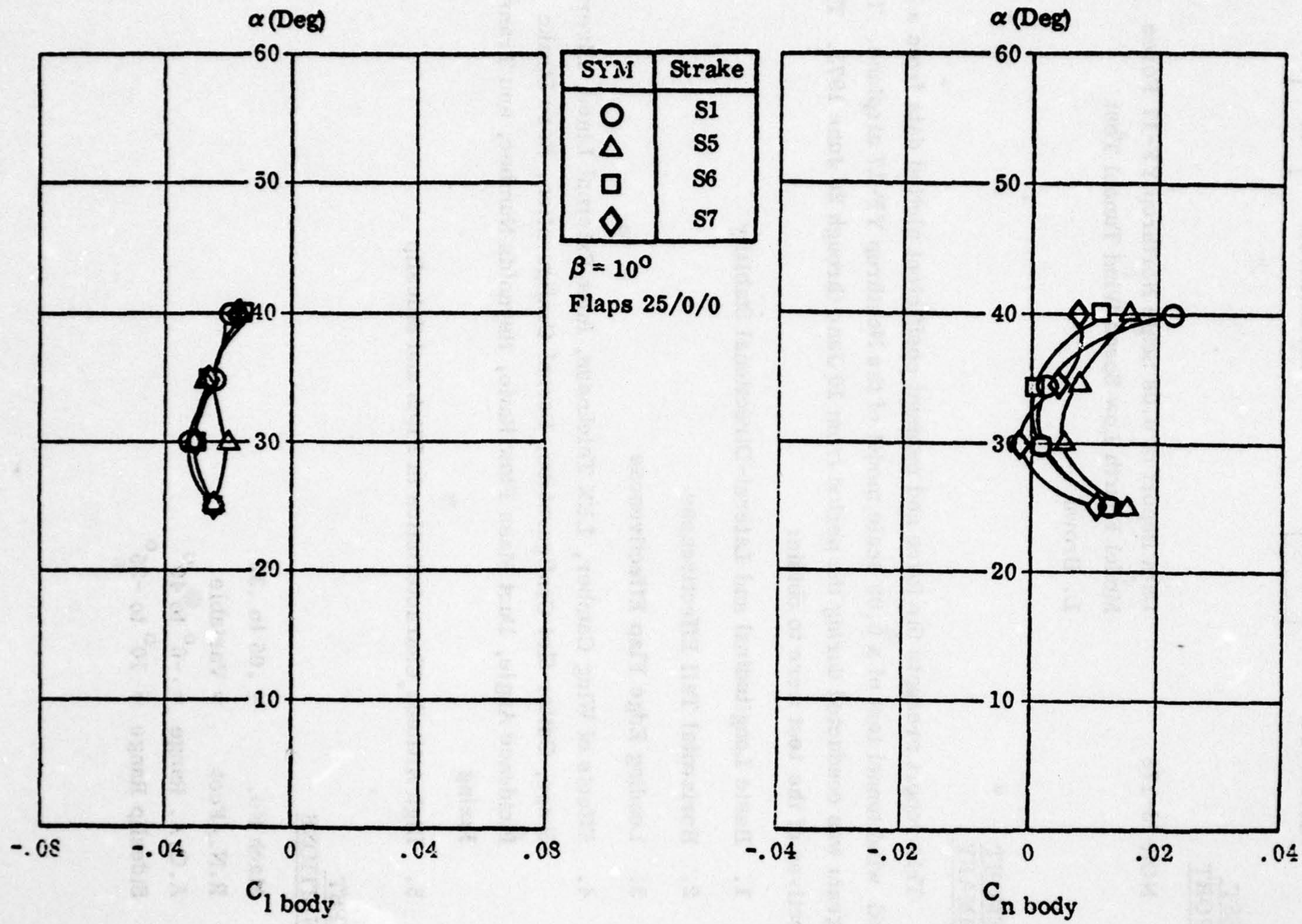


Figure 181. Effect of Nose Strakes

AIRCRAFT **YF-17** REFERENCE **35**

TEST REPORT

NOR 73-176 Data Report of 0.08 Scale Northrop YF-17 Force Model Fourth Low Speed Wind Tunnel Test

L. Brown

REPORT SUMMARY

This report presents the force and moment coefficient plotted data from a low speed wind tunnel test of a 0.08 scale model of the Northrop YF-17 airplane. This program was conducted during the period from 10 June through 20 June 1973. The objectives of the test were to obtain:

1. Basic Longitudinal and Lateral-Directional Stability
2. Horizontal Tail Effectiveness.
3. Leading Edge Flap Effectiveness
4. Effects of Wing Camber, LEX Thickness, Inlet External Lines, Diverter Shape, Gutter Slot Configuration, Dorsal Configuration, Nose Strake Incidence Angle, Duct Mass Flow Ratio, Reynolds Number, and Transition Fixing
5. High Attitude Characteristics in Pitch and Sideslip

TEST CONDITIONS

Mach No.	=	.05 to .32
R.N./Foot	=	Variable
A.O.A. Range	=	-6° to 40°
Sideslip Range	=	10° to -25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 182.

CONFIGURATION CHANGES

Sketches of LEX camber and nose strake configuration changes applicable to this study are shown in Figures 183 and 185.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 184 shows the effect on $C_{L_{MAX}}$ of LEX camber, W8 and W11 with single drooped leading edge flaps, 25°/0.

Nose strake incidence as defined in Figure 185 showed no effect on the pitch data, lateral/directional data was unavailable.

Figure 186 shows the effect on lateral/directional stability of vertical tail V2 with a flap setting of 25°/0°.

Data effects for other objectives outlined above was either insufficient or not considered pertinent.

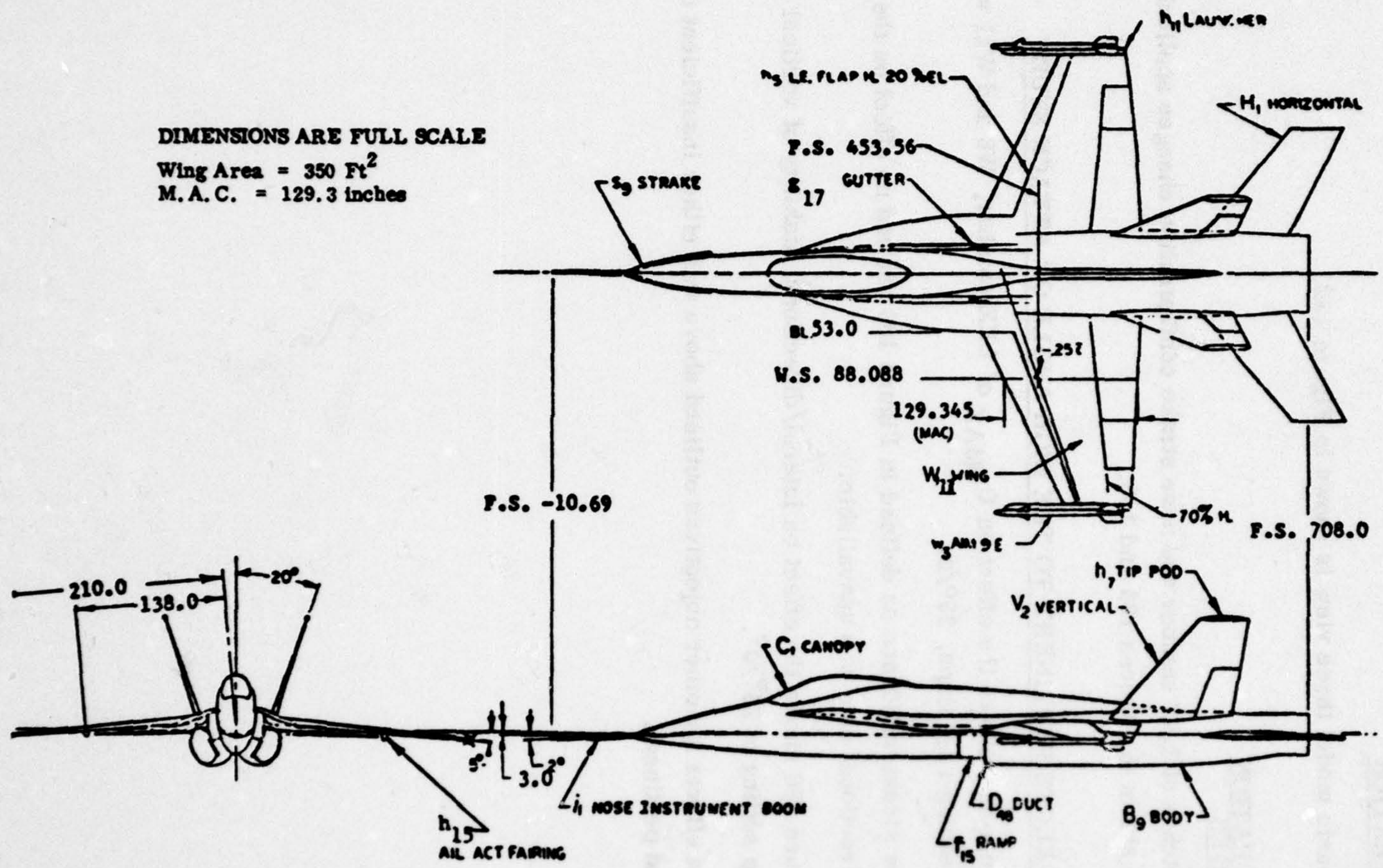


Figure 182. General Three View

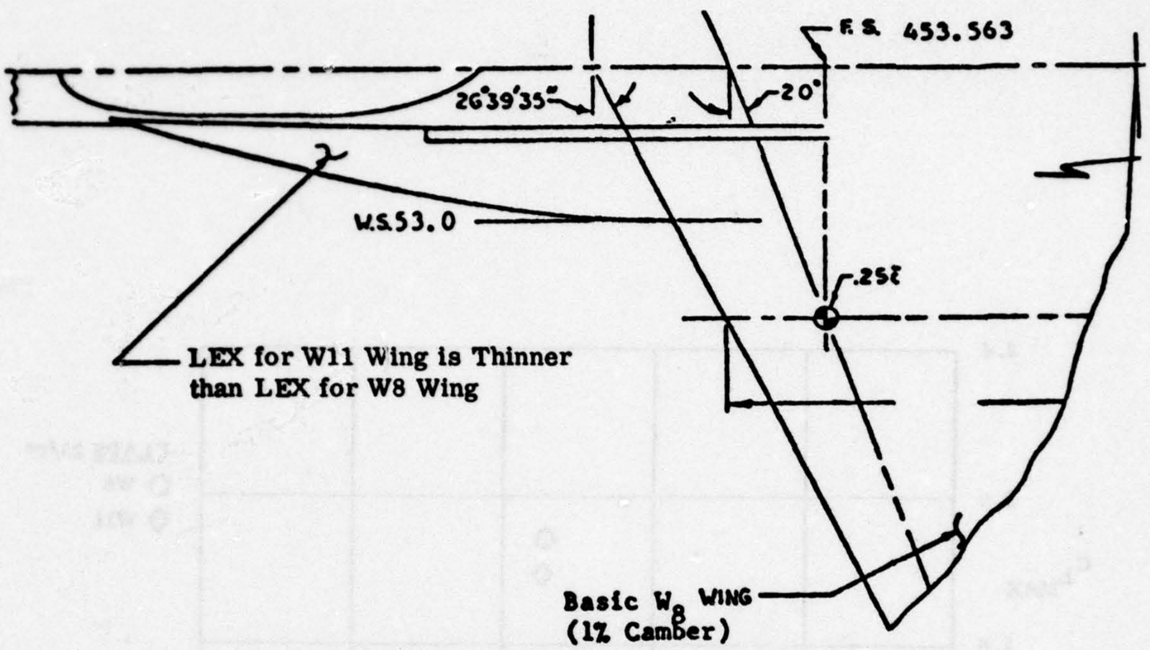


Figure 183. LEX CAMBER (W8, W11)

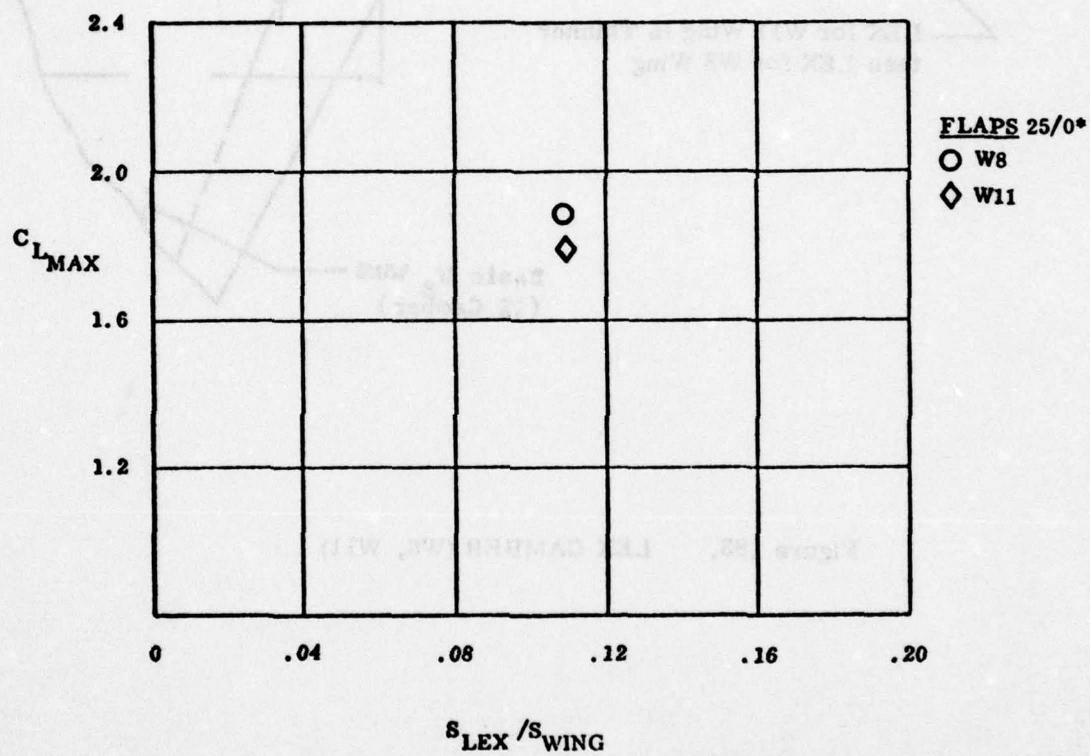
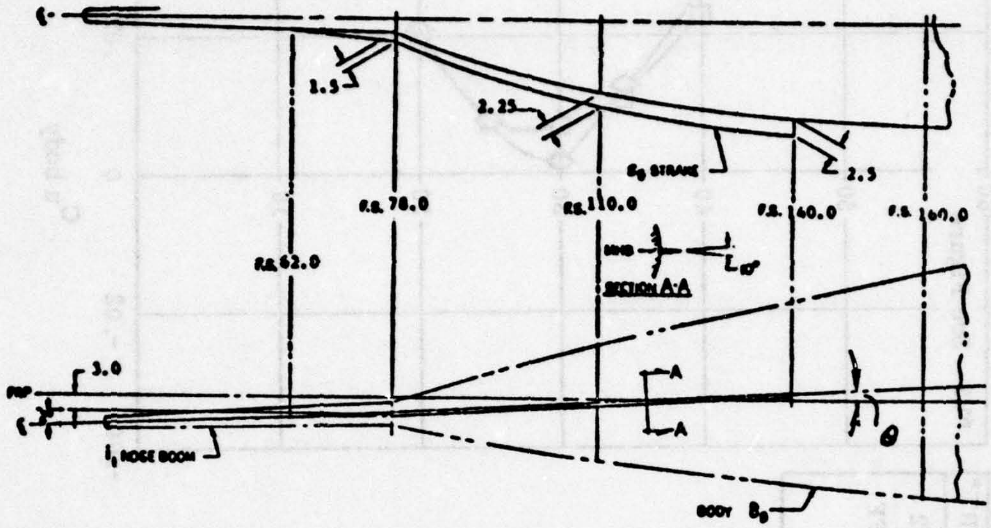


Figure 184. Effect of Lex Camber on $C_{L_{MAX}}$

*Note: Single Drooped L. E. Flaps



STRAKE	θ_S
S5	-3.5°
S9	-2.0°
S10	0.0°
S11*	-2.0°

*S11 is twice as wide as S9

Figure 185. Nose Strake Planforms

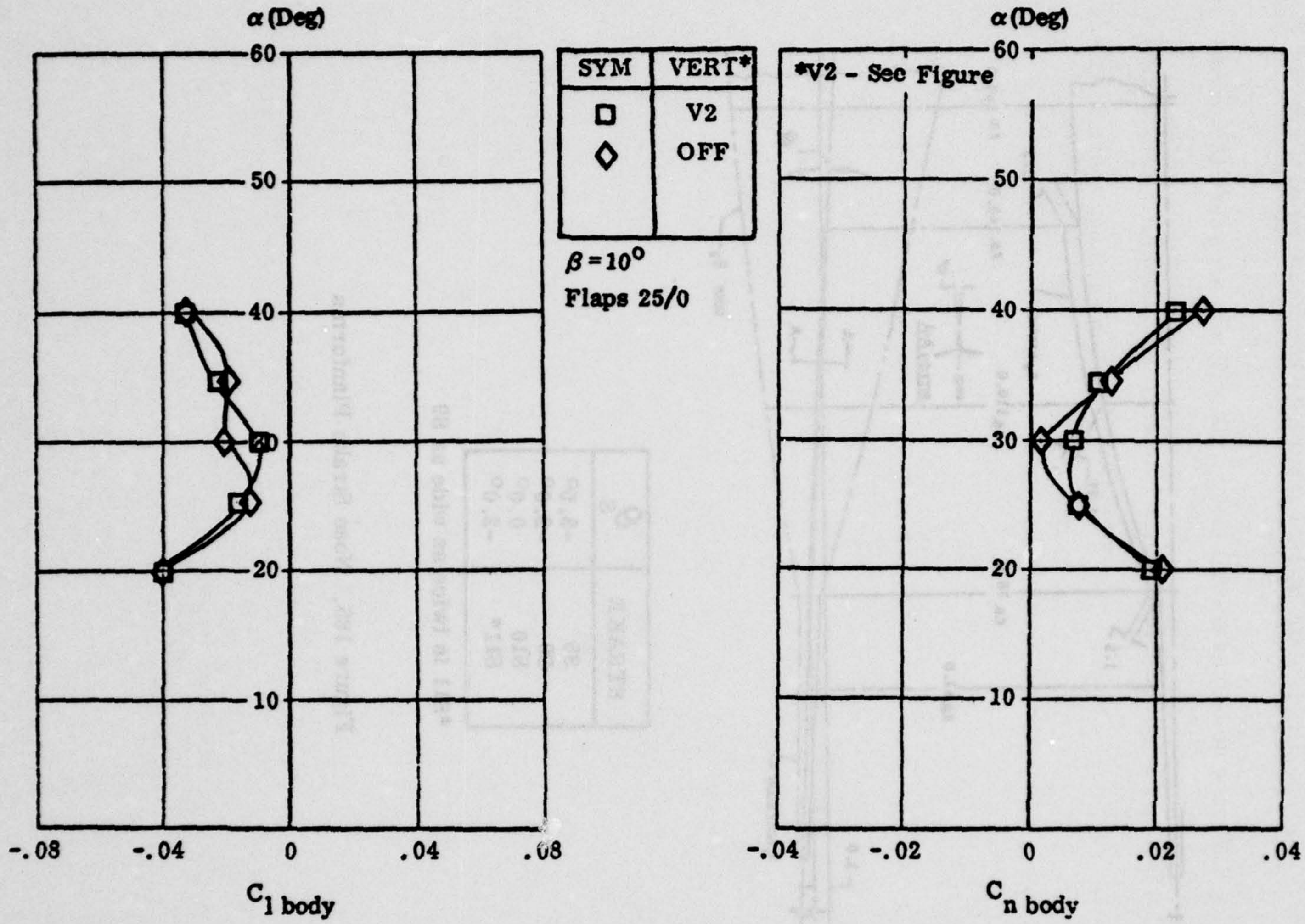


Figure 186. Effect of Vertical Tail

AIRCRAFT **YF-17** REFERENCE **36**

TEST REPORT

NOR 73-170 Data Report of a 0.08 Scale Northrop YF-17 Force Model Fifth Low Speed Wind Tunnel Test
E.G. Kontos

REPORT SUMMARY

This report presents the force and moment coefficient plotted data from a low speed wind tunnel test of a 0.08 scale model of the Northrop YF-17 airplane. This program was conducted during the period from 29 August to 6 September 1973.

The objectives of the test were to obtain:

1. Comparison of Gutter Slot Configuration
2. Comparison of Lex Planform
3. Comparison of Nose Strakes
4. Comparison of Horizontal Tail Deflections
5. Aileron Effectiveness
6. Effect of Vertical Tail
7. Correlation with T-049
8. Effects of Model Roll Orientations

TEST CONDITIONS

Mach No. = 0.3
R.N./Foot = 2.0×10^6
A.O.A. Range = -6° to 40°
Sideslip Range = Variable

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 187.

CONFIGURATION CHANGES

Sketches of LEX planform configuration changes applicable to this study are shown in Figure 188.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 189 shows the effect on $C_{L_{MAX}}$ of LEX planform, W8 and W16, and the effect of flap deflection $25^{\circ}/0$ with LEX W8.

Figure 190 shows the effect on lateral/directional stability of LEX planform, W8 and W16 with flaps $25^{\circ}/0^{\circ}$.

Figure 191 shows the effect on lateral/directional stability of strake incidence, S5, S9 and S10, and strake width S9 and S11, all with flaps $25^{\circ}/0^{\circ}$.

Data effects for objectives 1 and 4 through 8 listed above were either insufficient or not considered pertinent.

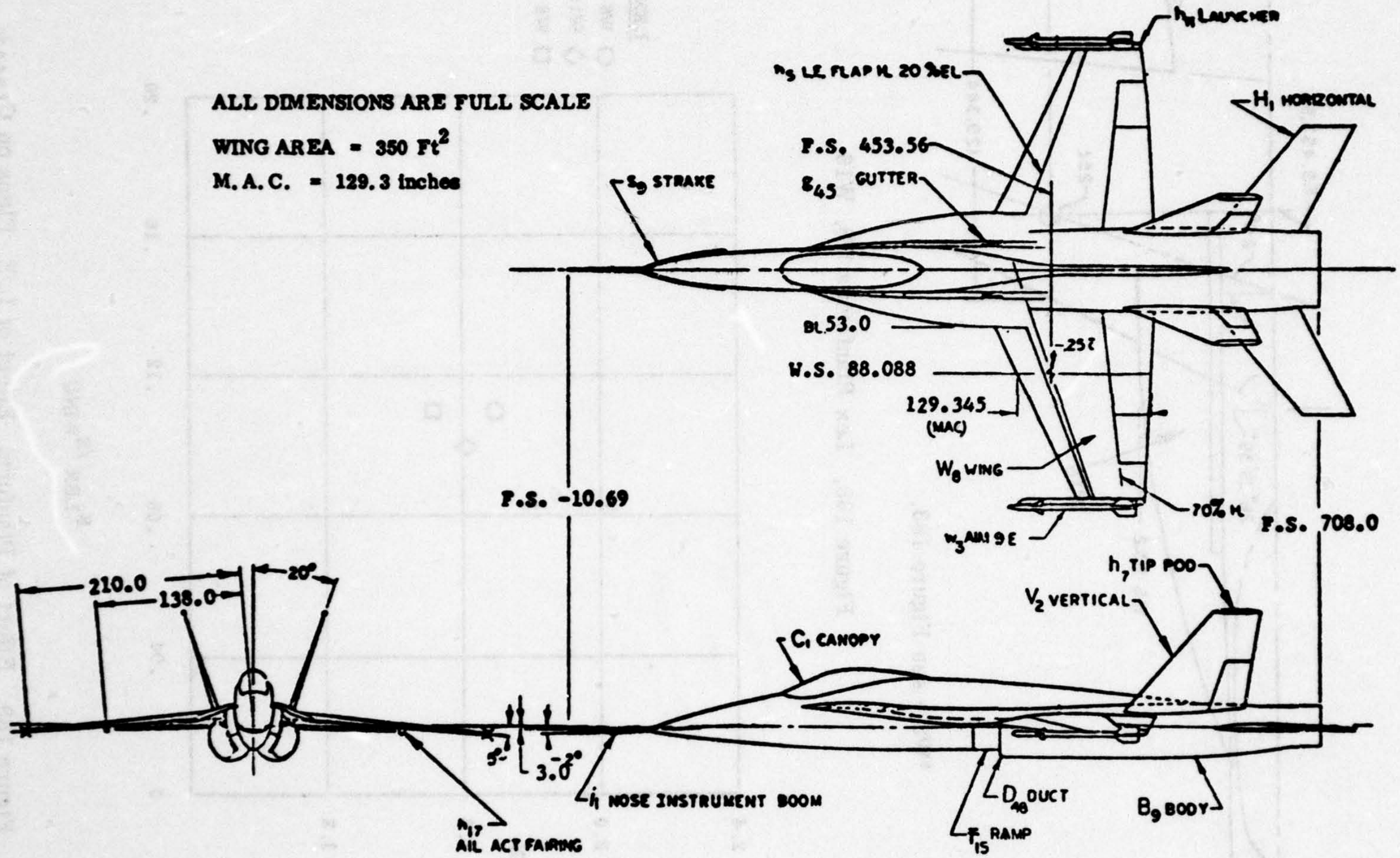
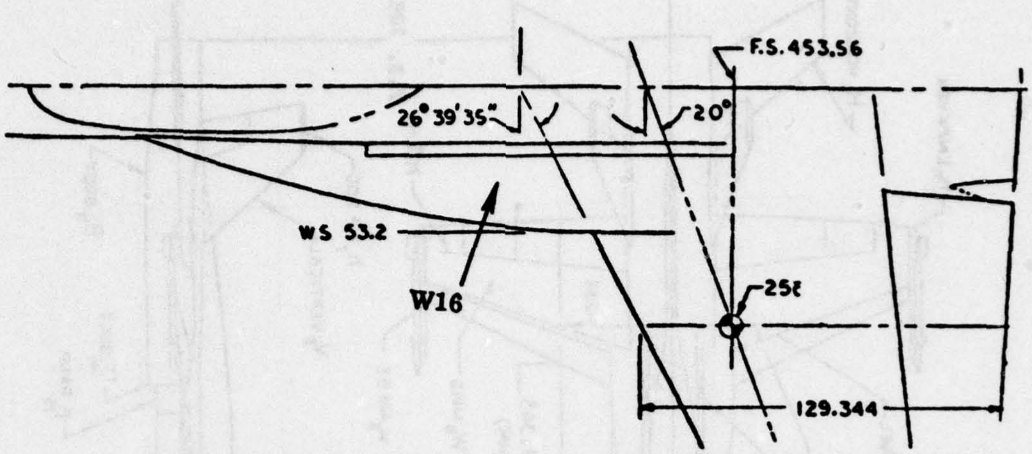


Figure 187. General Three View



*W8 - see Figure 183.

Figure 188. Lex Planforms W8, W16

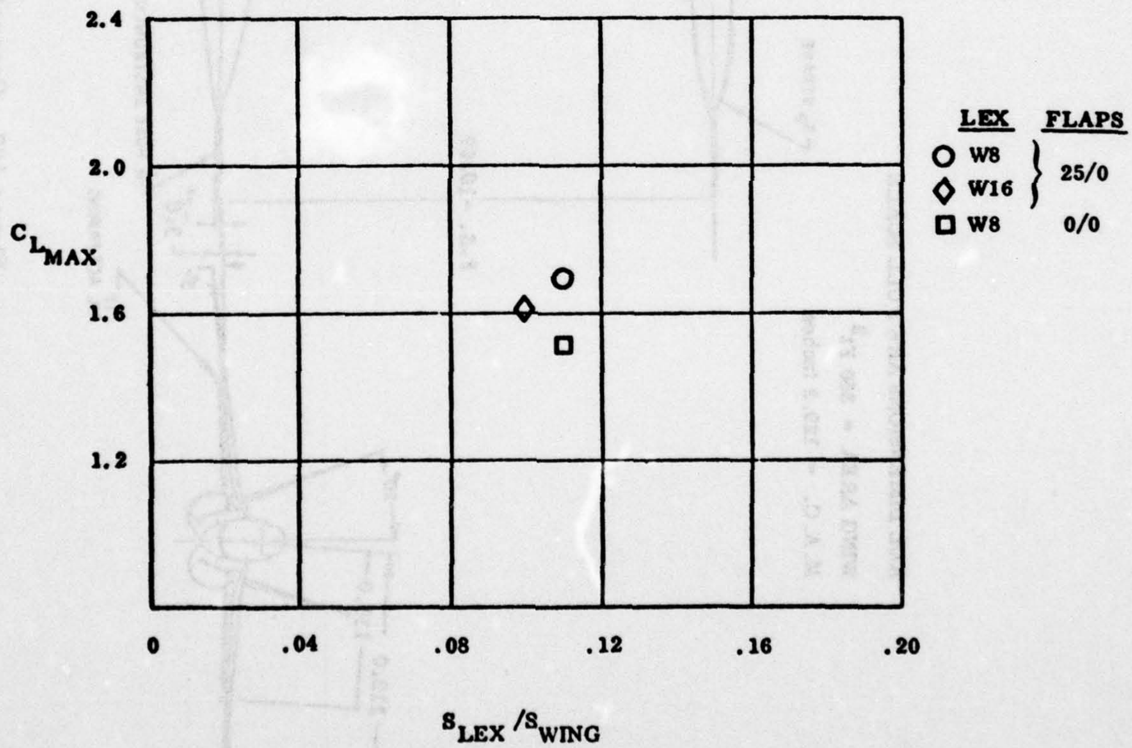


Figure 189. Effect of Planform, Effect of L. E. Flaps on $C_{L_{MAX}}$

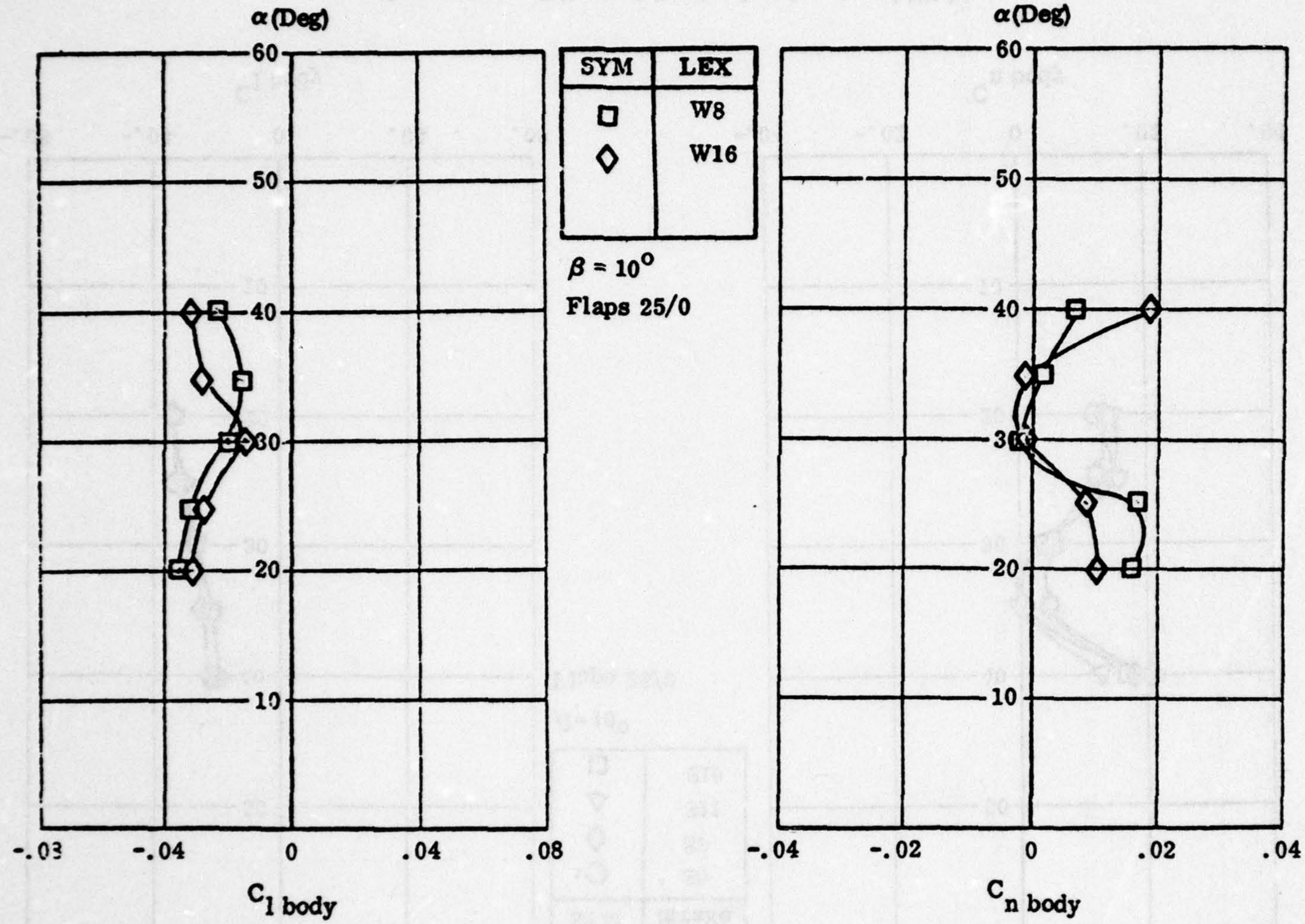


Figure 190. Effect of Lex Planform

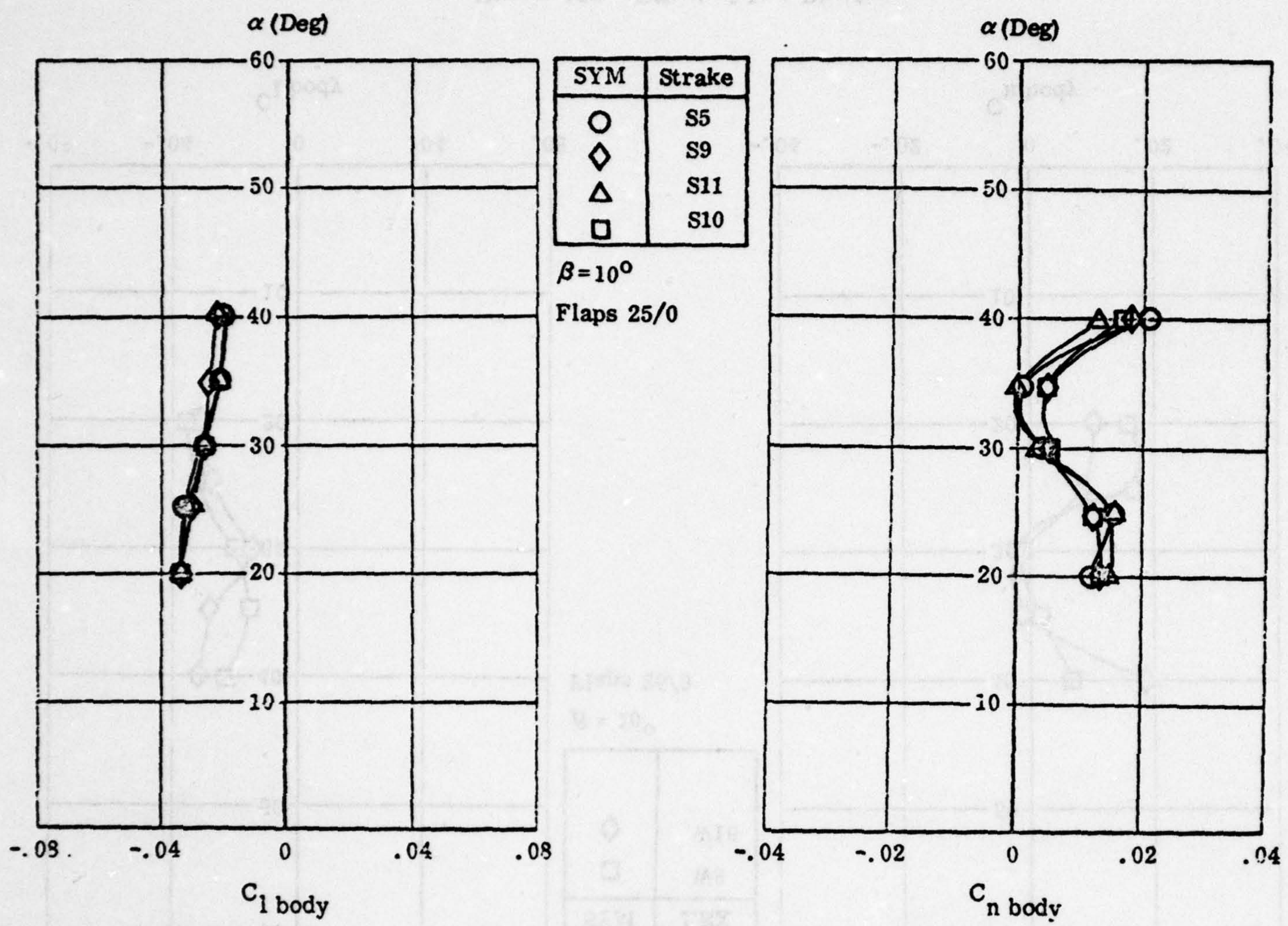


Figure 191. Effect of Strake Incidence and Width

AIRCRAFT | YF-17 | **REFERENCE** | 37 |

TEST REPORT

NOR 74-010 — **Data Report of a 0.08 Scale Northrop YF-17 Force Model Sixth Low Speed Wind Tunnel Test**

E.G. Kontos — **Volume I-III**

REPORT SUMMARY

This report presents the force and moment coefficient plotted data from a low speed wind tunnel test of a 0.08 scale model of the Northrop YF-17 airplane. This program was conducted during the period from 7 to 30 November 1973.

The primary purpose of the test was to assess the effects on drag of configuration modifications on the fuselage, wing gutter slot, and leading edge extension (LEX). A second purpose was to obtain basic aerodynamic data for the airplane to complement the data of Reference 7. Included in this were effect of external stores and speed brakes.

TEST CONDITIONS

Mach No. = 0.3

R.N./Foot = 2.0×10^6

A.O.A. Range = -6 to 40

Sideslip Range = -10 to 25

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 192.

CONFIGURATION CHANGES

Sketches of configuration changes applicable to this study are shown in Figure 192.

AD-A069 647 NORTHROP CORP HAWTHORNE CA AIRCRAFT GROUP F/G 20/4
ANALYSIS OF WIND TUNNEL DATA PERTAINING TO HIGH ANGLE OF ATTACK--ETC(U)
JUL 78 J W HEADLEY F33615-77-C-3062
UNCLASSIFIED NOR-78-69-VOL-2 AFFDL-TR-78-94-VOL-2 NL

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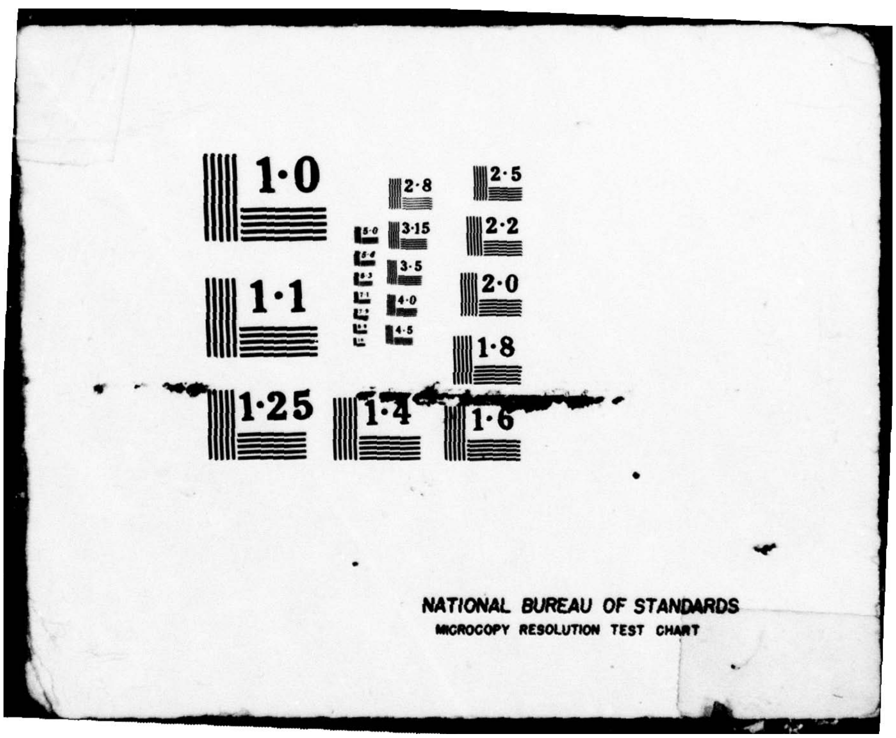

1·0
2·8
2·5
3·15
2·2
3·5
2·0
1·1
4·0
4·5
1·8
1·25
1·4
1·6
NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 193 shows the effect on C_{LMAX} of flap deflection on wing W18.

Figure 194 shows the effect on lateral/directional stability of vertical tail V2 at high attitudes and flaps deflected $25^{o}/0^{o}$.

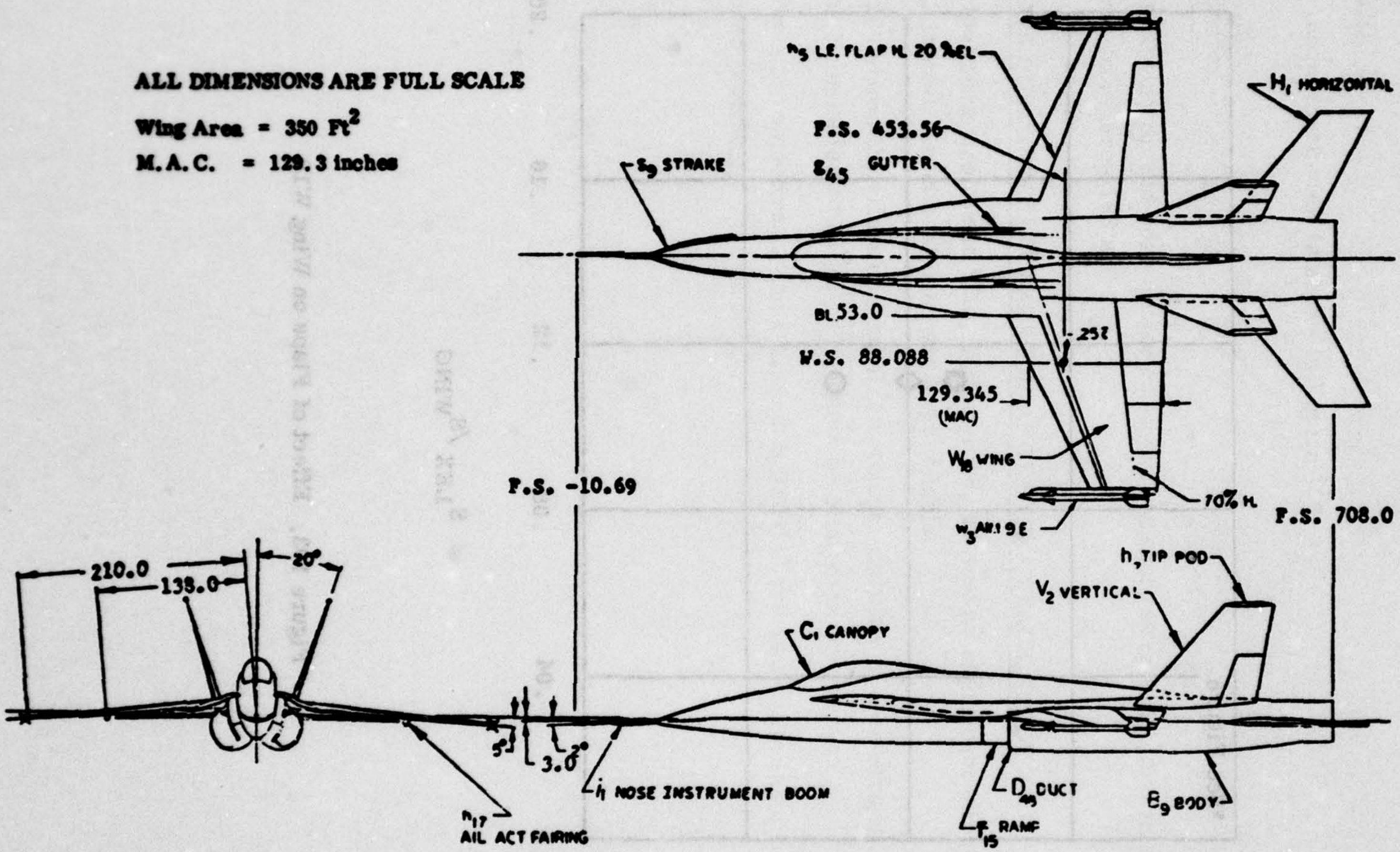


Figure 192. General Three View

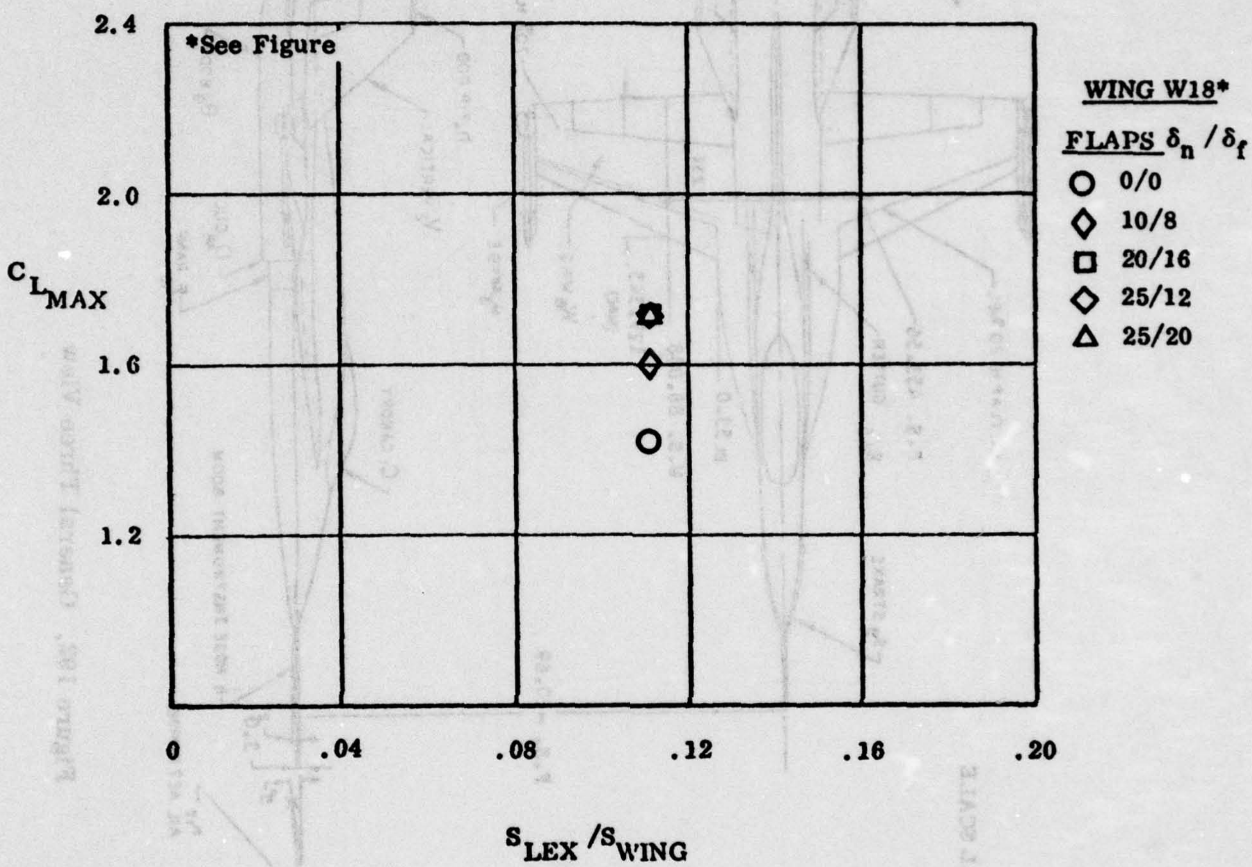


Figure 193. Effect of Flaps on Wing W18

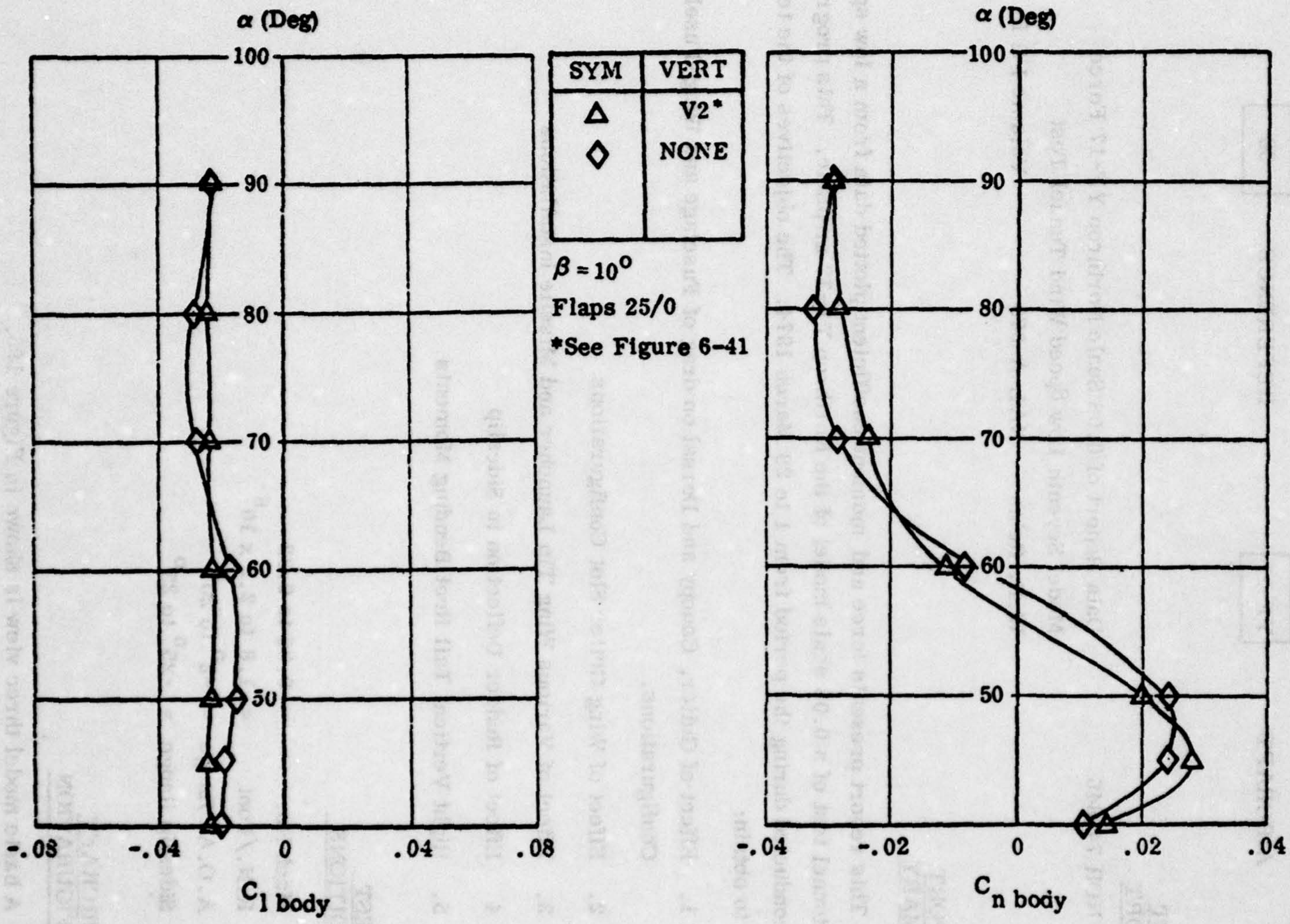


Figure 194. Effect of Vertical Tail at High Altitude

AIRCRAFT **YF-17** REFERENCE **38**

TEST REPORT

NOR 74-346 Data Report of 0.08 Scale Northrop YF-17 Force Model Seventh Low Speed Wind Tunnel Test
W.P. Rehm NAL-A-070 Volume I & II

REPORT SUMMARY

This report presents force and moment coefficient plotted data from a low speed wind tunnel test of a 0.08 scale model of the Northrop YF-17 airplane. This program was conducted during the period from 1 to 29 March 1974. The objectives of the test were to obtain:

1. Effect of Gutter, Canopy and Dorsal on drag of Fuselage and Wing-Fuselage Configurations.
2. Effect of Wing Gutter Slot Configurations
3. Effect of Various Wing Tip Launcher and Missile Installations
4. Effect of Rudder Deflection in Sideslip
5. Right Vertical Tail Root Bending Moments

TEST CONDITIONS

Mach No. = 0.26 to 0.32
R.N./Foot = 1.8 to 2.2 x 10^6
A.O.A. Range = -2° to 20°
Sideslip Range = -25° to 25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 195.

CONFIGURATION CHANGES

Sketches of wing tip configuration changes applicable to this study are shown in Figure 196.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

The various wing tips tested W18, W22 and W23, showed no significant effect on the pitch data, lateral/directional data was not available.

Data effects for objectives 1, 2, 4 and 5 listed above were either insufficient or not considered pertinent.

ALL DIMENSIONS ARE FULL SCALE

Wing Area = 350 Ft^2

M.A.C. = 129.3 inches

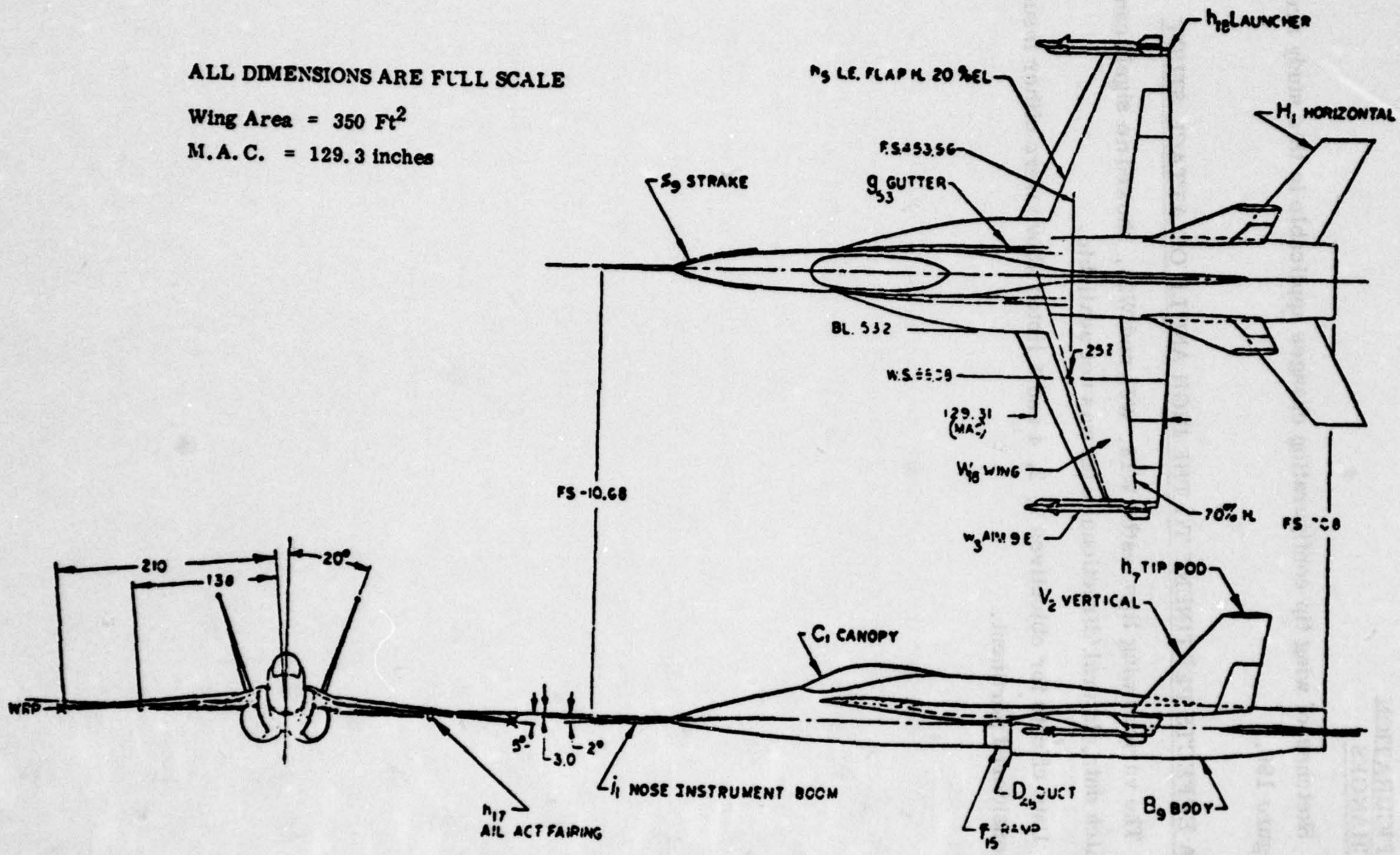


Figure 195. Genral Three View

WINGS

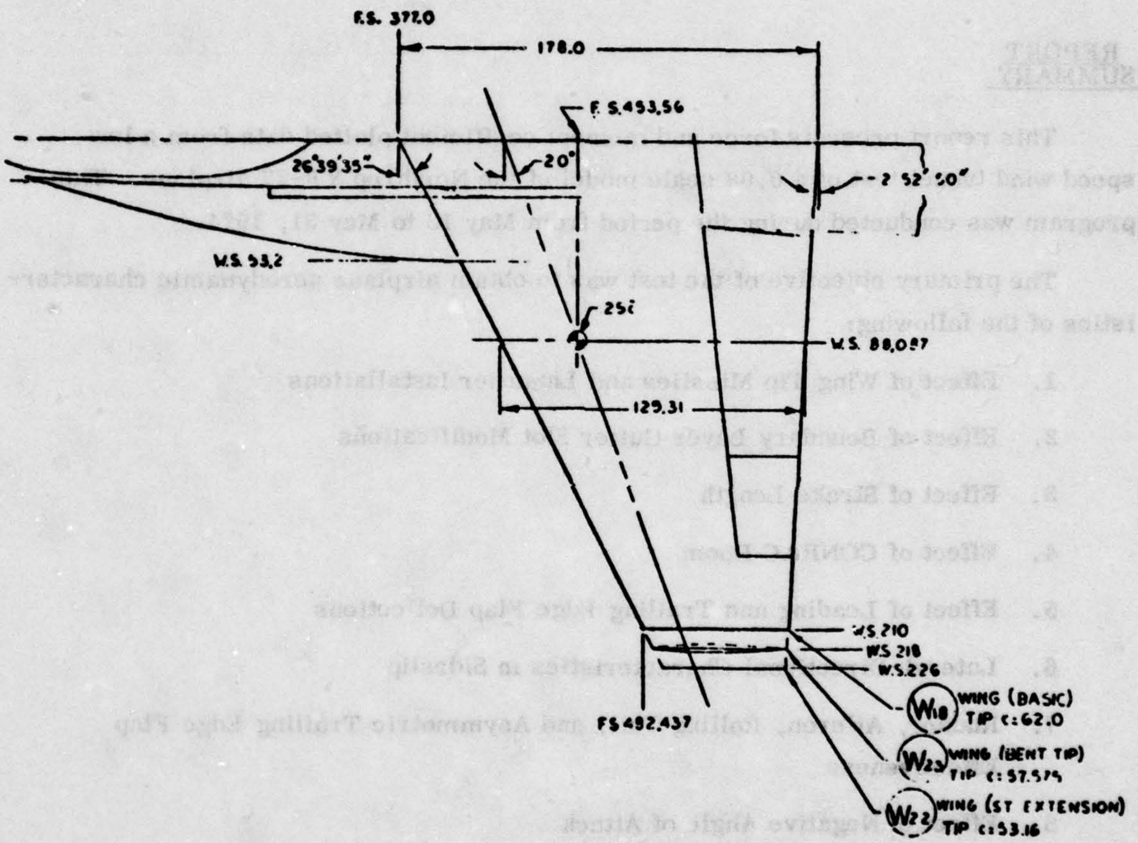


Figure 196. Wing Tips W18, W22, W23

AIRCRAFT **YF-17** REFERENCE **39**

TEST REPORT

NOR 74-347 — Data Report of a 0.08 Scale Northrop YF-17 Model Eighth Low Speed Wind Tunnel Test

W.P. Rehm NAL-A-083 Volume I & II

REPORT SUMMARY

This report presents force and moment coefficient plotted data from a low speed wind tunnel test of a 0.08 scale model of the Northrop YF-17 airplane. This program was conducted during the period from May 13 to May 31, 1974.

The primary objective of the test was to obtain airplane aerodynamic characteristics of the following:

1. Effect of Wing Tip Missiles and Launcher Installations
2. Effect of Boundary Layer Gutter Slot Modifications
3. Effect of Strake Length
4. Effect of CONRAC Boom
5. Effect of Leading and Trailing Edge Flap Deflections
6. Lateral-Directional Characteristics in Sideslip
7. Rudder, Aileron, Rolling Tail, and Asymmetric Trailing Edge Flap Effectiveness
8. Effect of Negative Angle of Attack
9. High Attitude Characteristics

TEST CONDITIONS

Mach No. = 0.25 to 0.32
R.N./Foot = $1.8 \times 2.2 \times 10^6$
A.O.A. Range = -6° to 40°
Sideslip Range = -10° to 23°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 197.

CONFIGURATION CHANGES

Sketches of wing tip and nose strake configuration changes applicable to this study are shown in Figures 198 and 199.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

The various wing tips tested W18, W25 and W6, showed no significant effect on the pitch data, lateral/directional data was not available.

Figure 200 shows the effect on lateral/directional stability of nose strake length S9 and S13 with flaps deflected $25^o/0^o$. No effect on pitch data was shown.

Data effects for objectives 1 and 4 through 9 listed above was either insufficient or not considered pertinent.

ALL DIMENSIONS ARE FULL SCALE

Wing Area = 350 Ft^2

M.A.C. = 129.3 inches

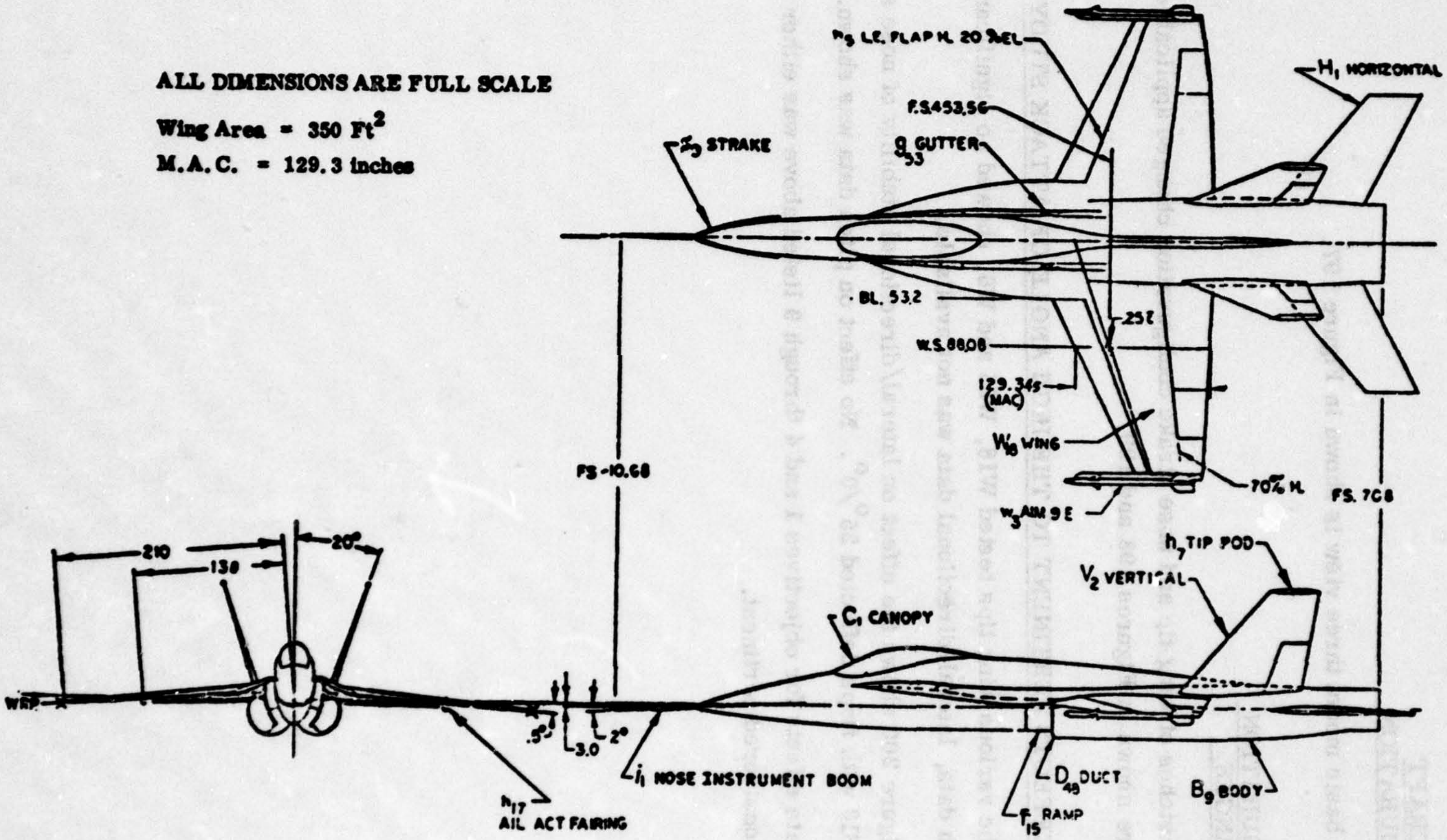


Figure 197. General Three View

WINGS

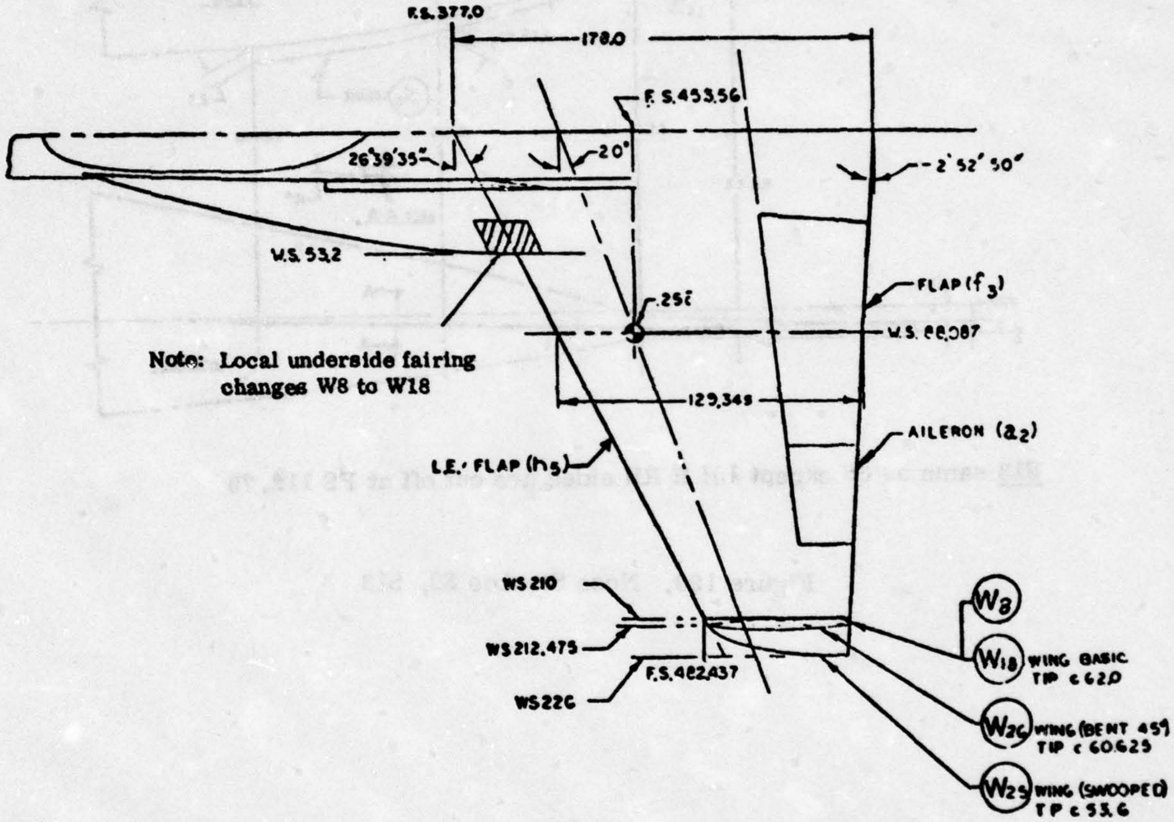
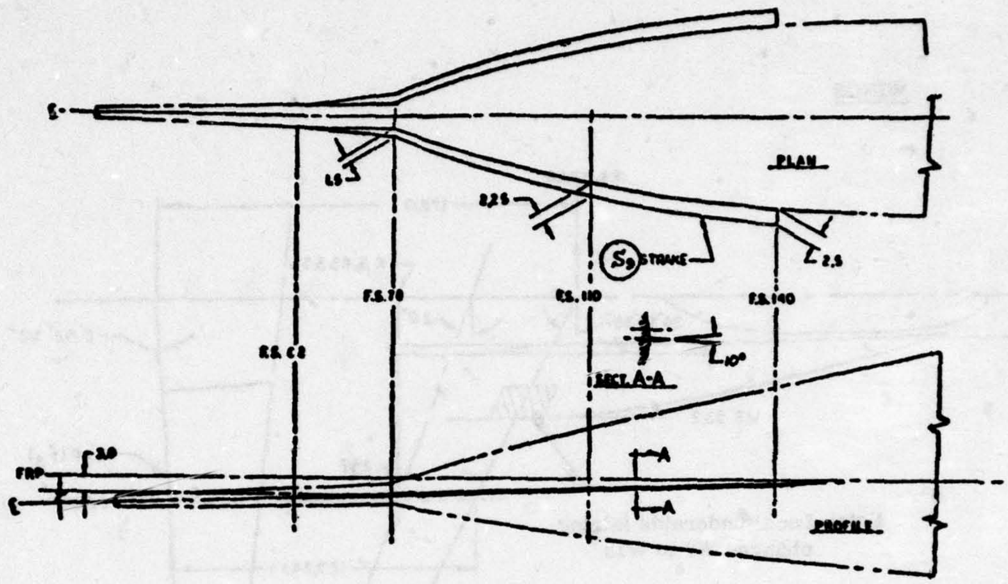


Figure 198. Wing Tips W18, W25, W26



<u>S13</u> same as S9 except LH & RH sides are cut off at FS 112.75

Figure 199. Nose Strakes S9, S13

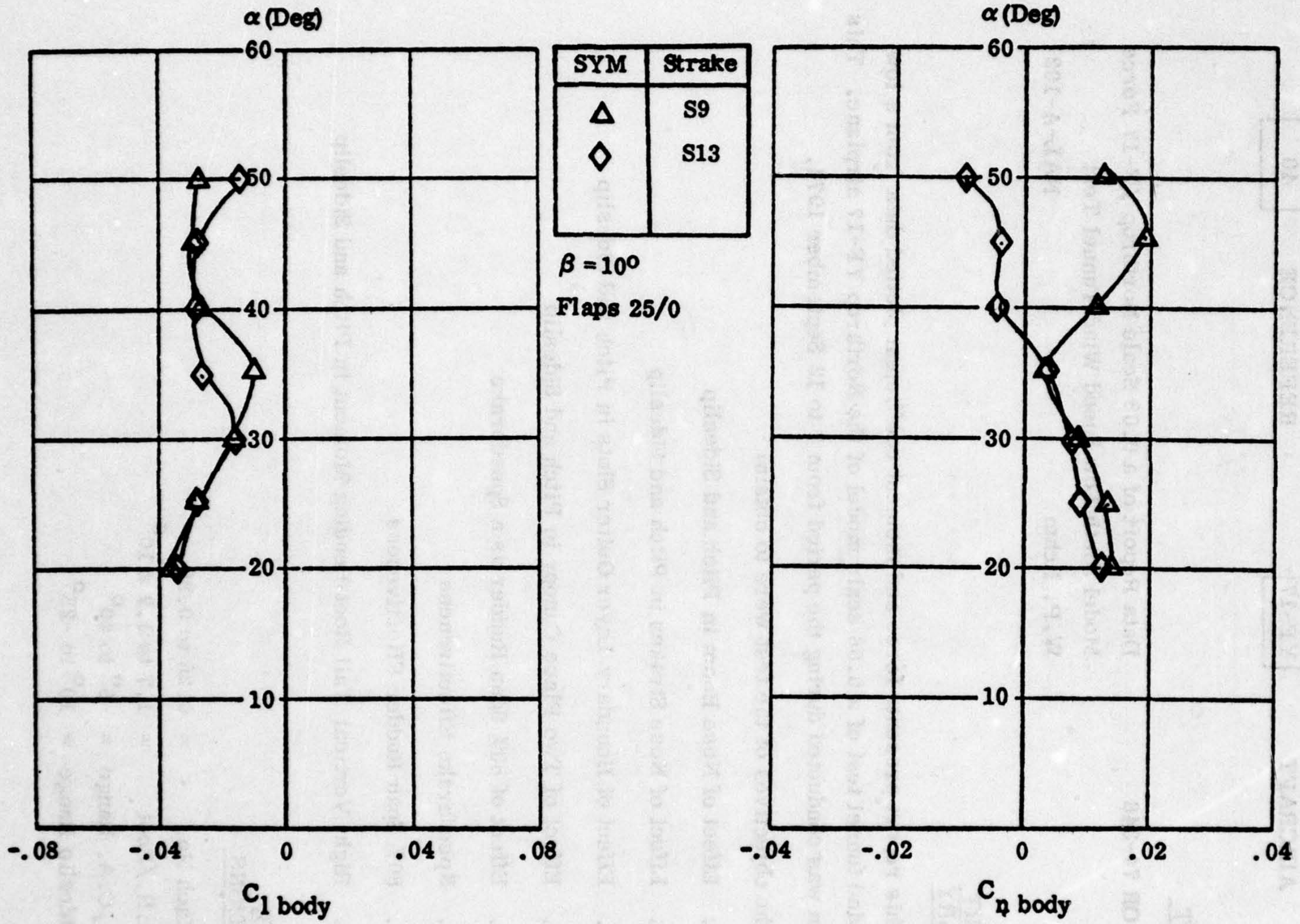


Figure. 200. Effect of Nose Strake Length

AIRCRAFT **YF-17** REFERENCE **40**

TEST REPORT

NOR 74-348 Data Report of a 0.08 Scale Northrop YF-17 Force Model Ninth Low Speed Wind Tunnel Test
W.P. Rehm NAL-A-102

REPORT SUMMARY

This report presents force and moment coefficient plotted data from a low speed wind tunnel test of a 0.08 scale model of the Northrop YF-17 airplane. This program was conducted during the period from 7 to 12 September 1974.

The objectives of the test were to obtain:

1. Effect of Nose Boom in Pitch and Sideslip
2. Effect of Nose Strakes in Pitch and Sideslip
3. Effect of Boundary Layer Gutter Slots in Pitch and Sideslip
4. Effect of Two Place Canopy in Pitch and Sideslip
5. Effect of 80% Span Rudder as a Speedbrake
6. Speedbrake Effectiveness
7. 80% Span Rudder Effectiveness
8. Right Vertical Tail Root Bending Moment in Pitch and Sideslip

TEST CONDITIONS

Mach No.	= 0.26 to 0.29
R.N./Foot	= 1.7 to 1.9 x 10^6
A.O.A. Range	= -6° to 40°
Sideslip Range	= 10° to -25°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 197.

CONFIGURATION CHANGES

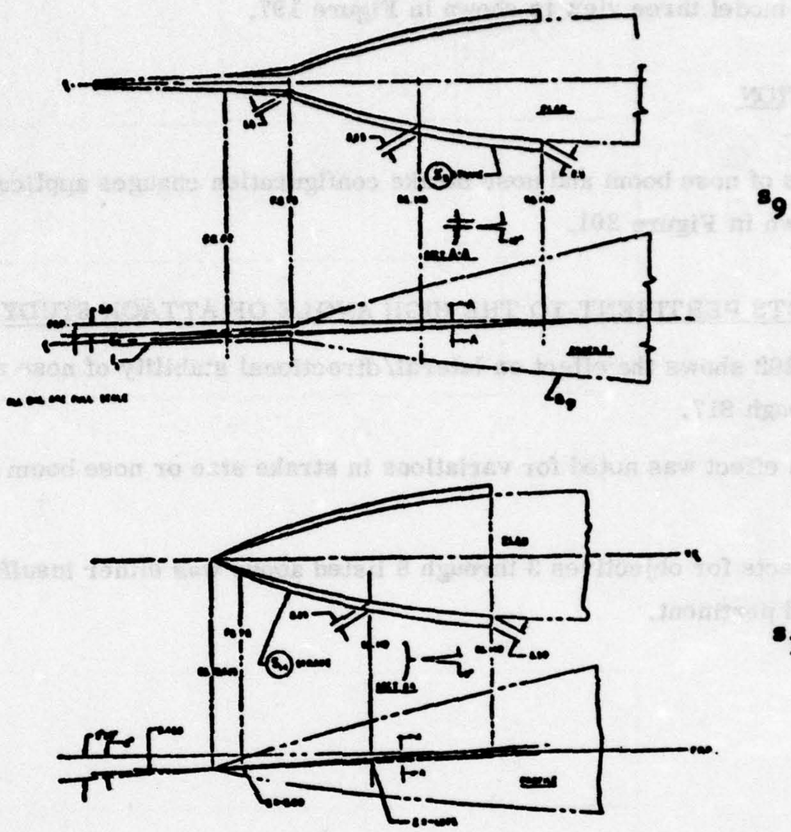
Sketches of nose boom and nose strake configuration changes applicable to this study are shown in Figure 201.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 202 shows the effect on lateral/directional stability of nose strake size, S14 through S17.

No pitch effect was noted for variations in strake size or nose boom difference, S9 and S14.

Data effects for objectives 3 through 8 listed above was either insufficient or not considered pertinent.



S15 is half width S14

S16 is S14 cut back to FS 94

S17 is S14 cut back to FS 117

Figure 201. Nose Boom and Nose Strakes S9, S14-S17

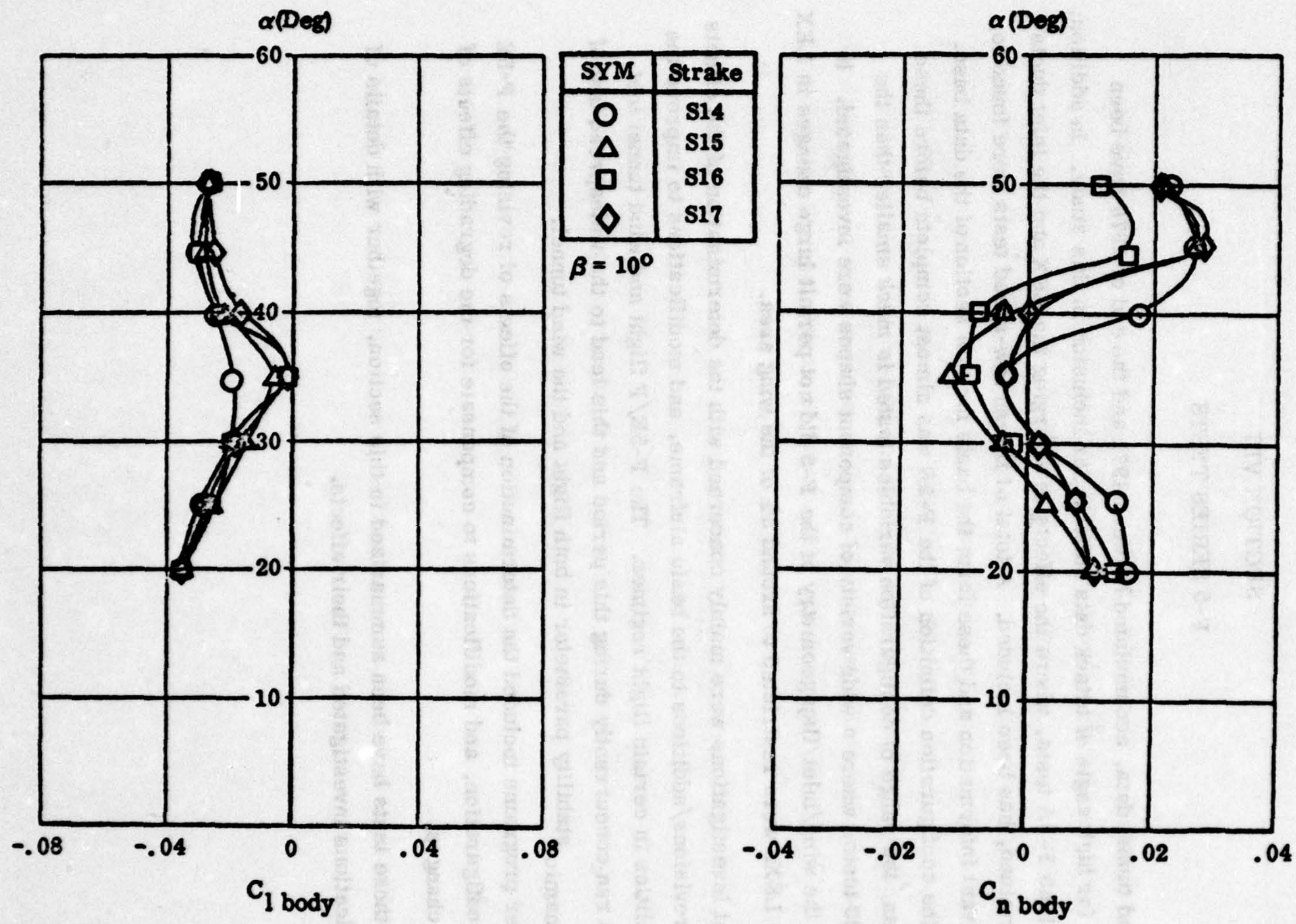


Figure 202. Effect of Nose Strake Size

SECTION VIII

F-5 SERIES TESTS

Wind tunnel data, accumulated between 1971 and the end of 1976 have been surveyed for high angle of attack data suitable for inclusion in this study. In addition, the final 1968 F-5A tests, where the effects of enlarging the LEX and the inlet ducts was determined, has been included. A total of fifteen low-speed tests were found to have relevant information and these form the basis for this section of the data base. Because the configuration definition of the F-5E was almost complete before these tests began, the range of configuration variables tested is much smaller than the N300-P530 tests, where a wide variety of component shapes were investigated. In addition, the wing/inlet/flap geometry of the F-5 did not permit large changes in LEX size, and LEXs were restricted to around 5% of the wing area.

Test investigations were mainly concerned with the determination of the effects of small revisions/additions to the basic airframe, and modifications to improve the flying qualities in certain flight regimes. The F-5E/F flight and wind tunnel test programs ran concurrently during this period and this lead to the widespread use of the $C_{n_{\beta\,dynamic}}$ stability parameter in both flight and the wind tunnel.

Other programs included the determination of the effects of revising the F-5E to the F configuration, and modifications to compensate for the degrading effects of proposed changes.

All these tests have been summarized in this section, together with details of the modifications investigated and their effects.

AIRCRAFT **F-5A** REFERENCE **41**

TEST REPORT

NOR 68-102 Data Report of a 1/7 Scale Model F-5A Low Speed Wind Tunnel Test Investigation of the Effects of Wing Leading Edge Extensions and Extended Inlet Ducts

G. L. Danek NRL-A-835

REPORT SUMMARY

This report presents longitudinal and lateral-directional force data from a low speed wind tunnel test of a 1/7 scale model of the F-5A airplane. The test program was conducted during the period from 25 through 29 April 1968.

The objective of the test was to determine the effect of wing leading edge extensions and extended engine inlet ducts on the stability and performance of the aircraft.

TEST CONDITIONS

Mach No.	=	0.22
R. N./Foot	=	1.4×10^6
A. O. A. Range	=	-2 to 28°
Sideslip Range	=	0 to 16°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 203.

CONFIGURATION CHANGES

Sketches of LEX sweep, LEX area and duct extension configuration changes applicable to this study are shown in Figures 204 and 206.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 205 shows the effect on $C_{L_{MAX}}$ of various LEX's W14, W44, W45 and various flap deflections.

Figure 207 shows the effect on pitch data of the basic and extended intake duct, D18 and D36.

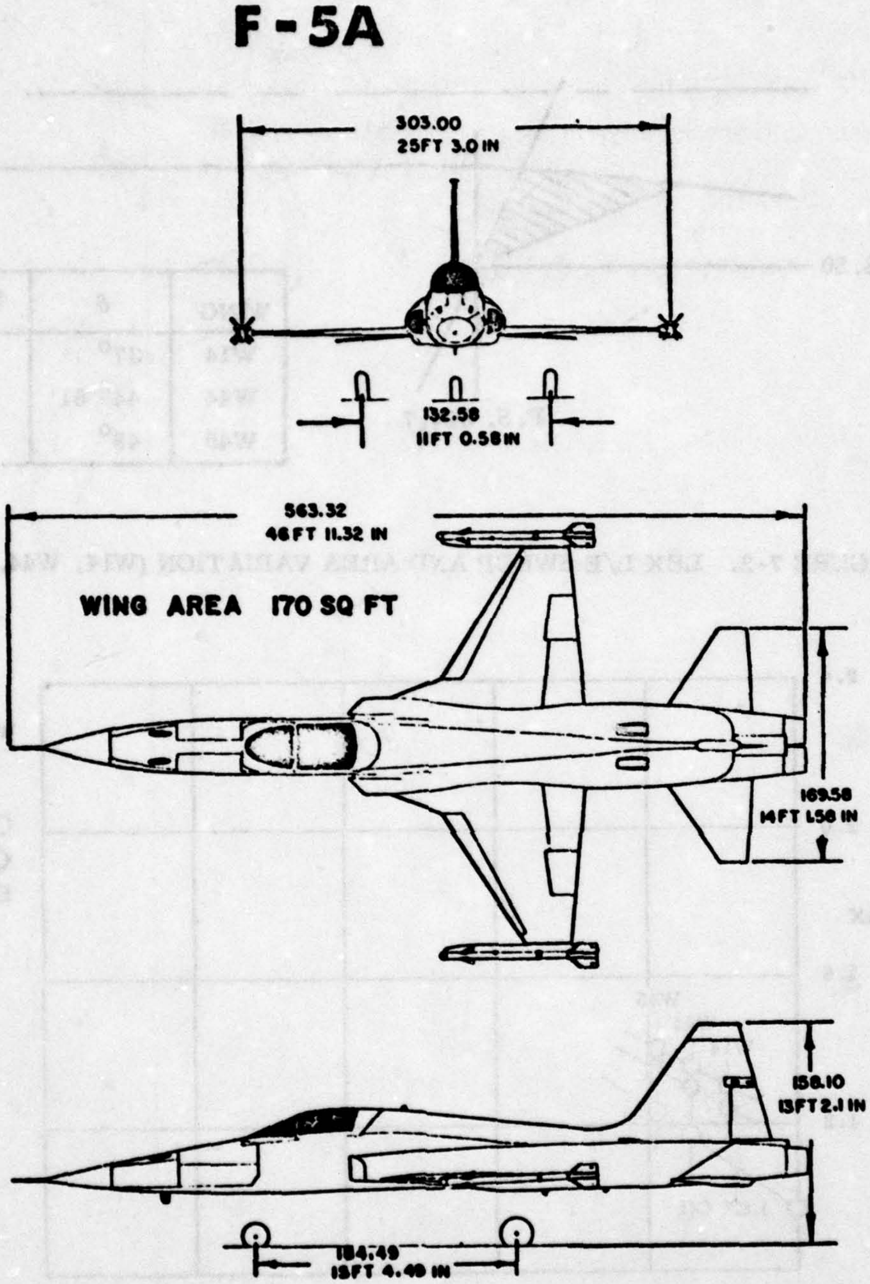
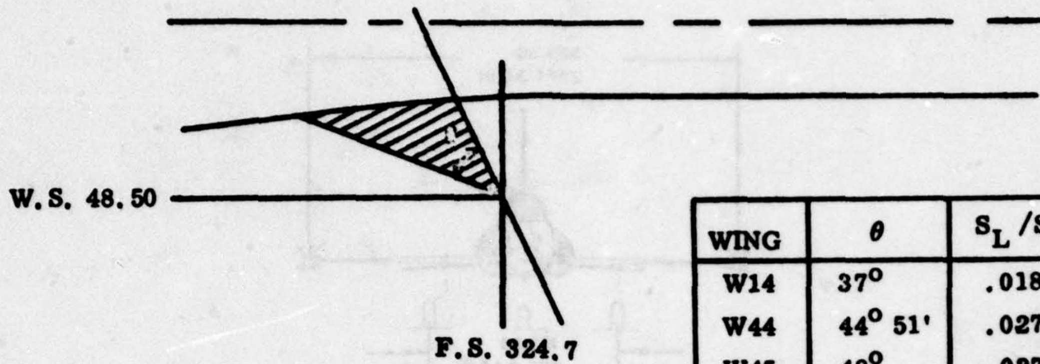


Figure 203. F-5A General Three View



WING	θ	S_L/S_W
W14	37°	.0185
W44	44° 51'	.0273
W45	48°	.037

FIGURE 7-2. LEX L/E SWEEP AND AREA VARIATION (W14, W44, W45)

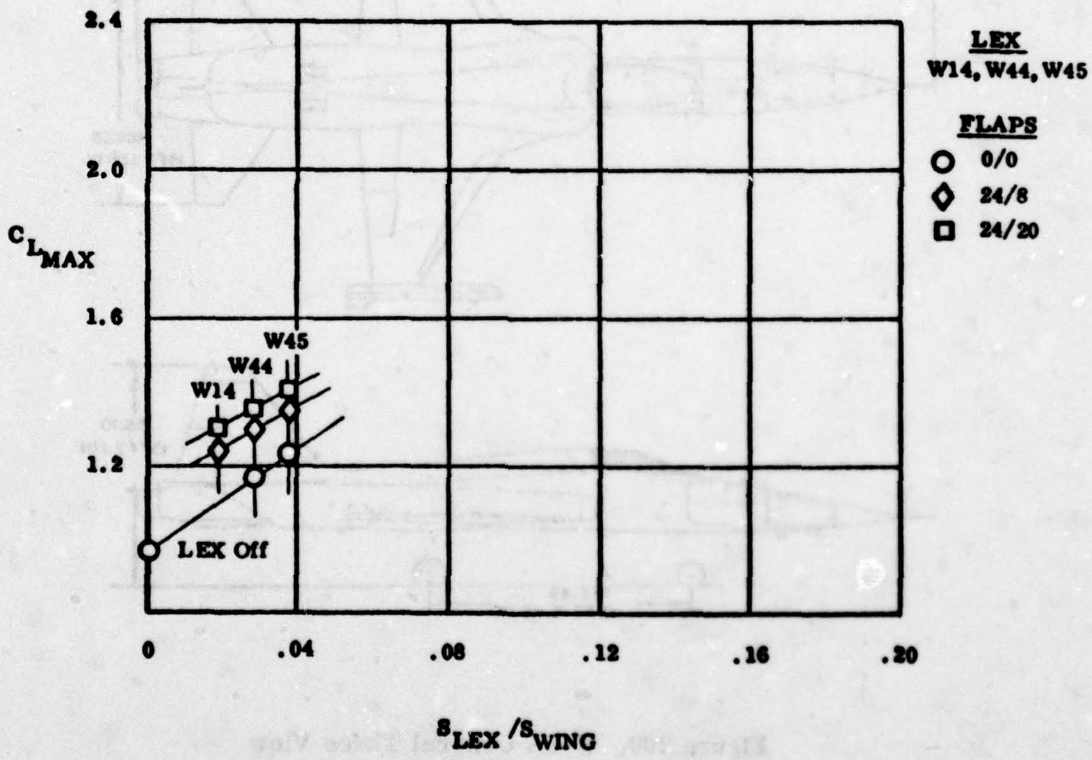


Figure 205. Effect of Lex Area and Flaps

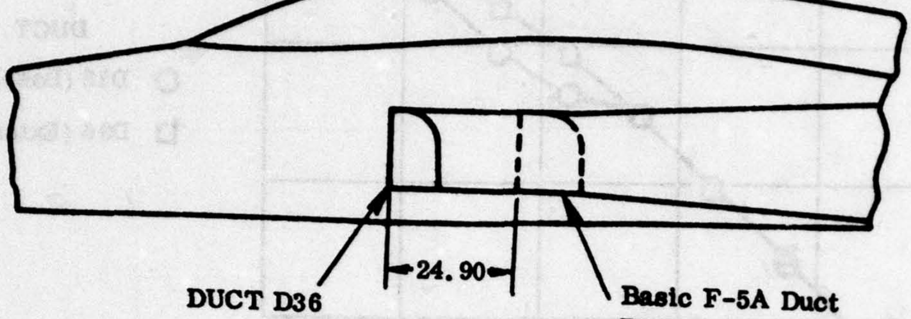


Figure 206. Duct Extensions D18, D36

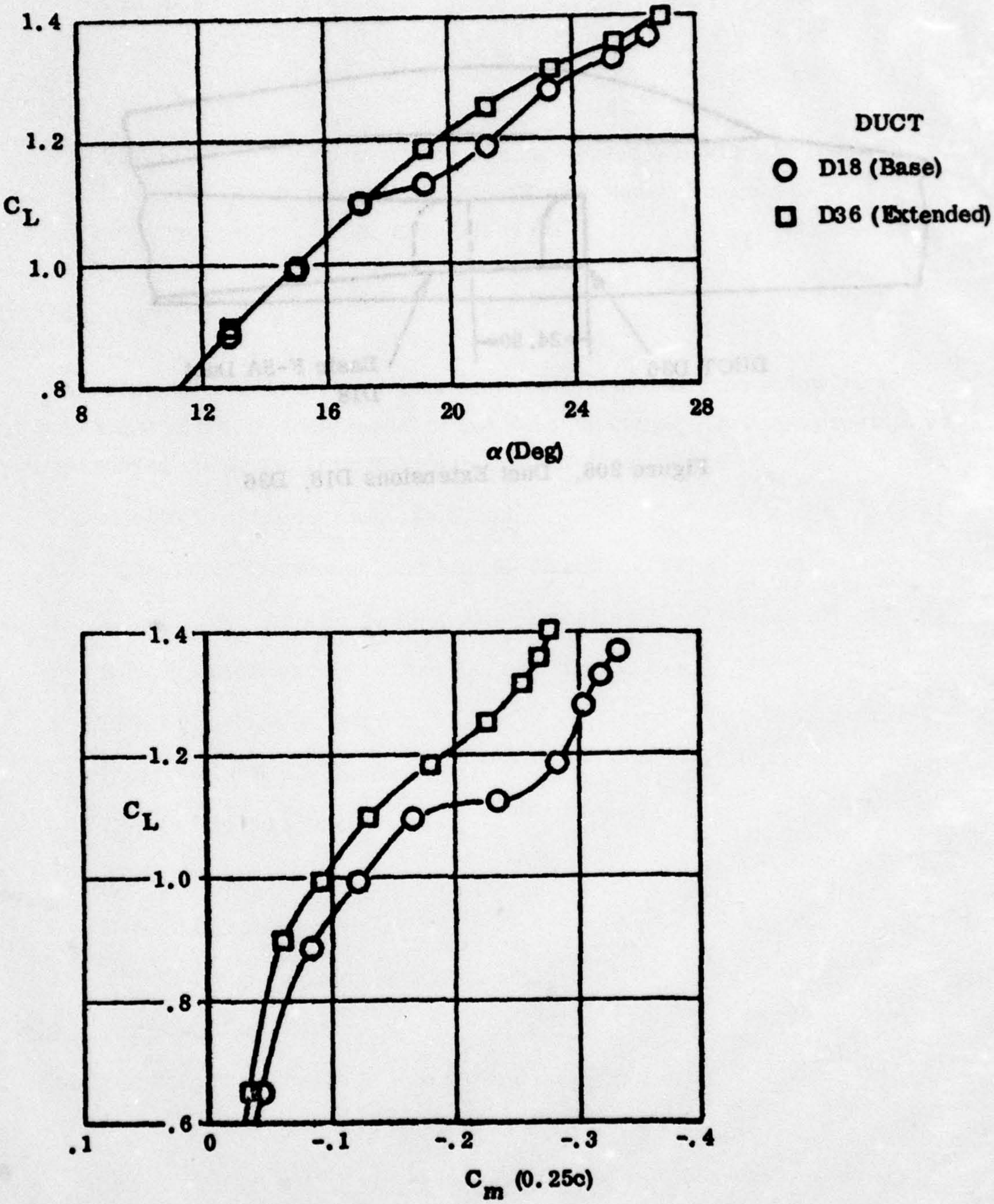


Figure 207. Effect of Duct Extension

AIRCRAFT **F-5E** REFERENCE **42**

TEST REPORT

NOR 71-86 — Data Report of a Low Speed Wind Tunnel Test of a 0.10 Scale F-5E Force Model First Low Speed Test

B. J. de la Puerta — NAL-A-928

REPORT SUMMARY

This report presents force and moment coefficient data for a low speed wind tunnel test of a 0.10 scale model of the F-5E Airplane. This test program was conducted during the period from 8 January 1971 to 5 February 1971.

The objectives of the test were to obtain:

1. Model basic longitudinal and lateral-directional characteristics
2. Effect of various wing leading edge extensions
3. Effect of vertical tail dorsal
4. Effect of wing trailing edge flap deflection
5. Horizontal tail effectiveness
6. Effect of pylons and stores
7. Effect of speed brakes
8. Aileron effectiveness
9. Rudder effectiveness
10. High attitude data (up to 90°)

TEST CONDITIONS

Mach No.	=	0.28
R. N./Foot	=	1.9×10^6
A. O. A. Range	=	-10° to 40°
Sideslip Range	=	0 to -20°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 208.

CONFIGURATION CHANGES

Sketches of Canard, ventral, dorsal and LEX configuration changes applicable to this study are shown in Figures 209 and 211. (F-5E Nomenclature used from now on.)

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 210 shows the effect on directional stability of the following configuration changes; dorsal V2, ventral F7 and canard F6.

Figure 212 shows the effect on $C_{L_{MAX}}$ of flap deflection and the following LEX geometries;

LEX Area, W1, W2, W3 and W6
LEX Airfoil, W3 and W5
LEX Addition, W1 and W2.

Data effects for objectives 5 through 10 was either insufficient or not considered pertinent.

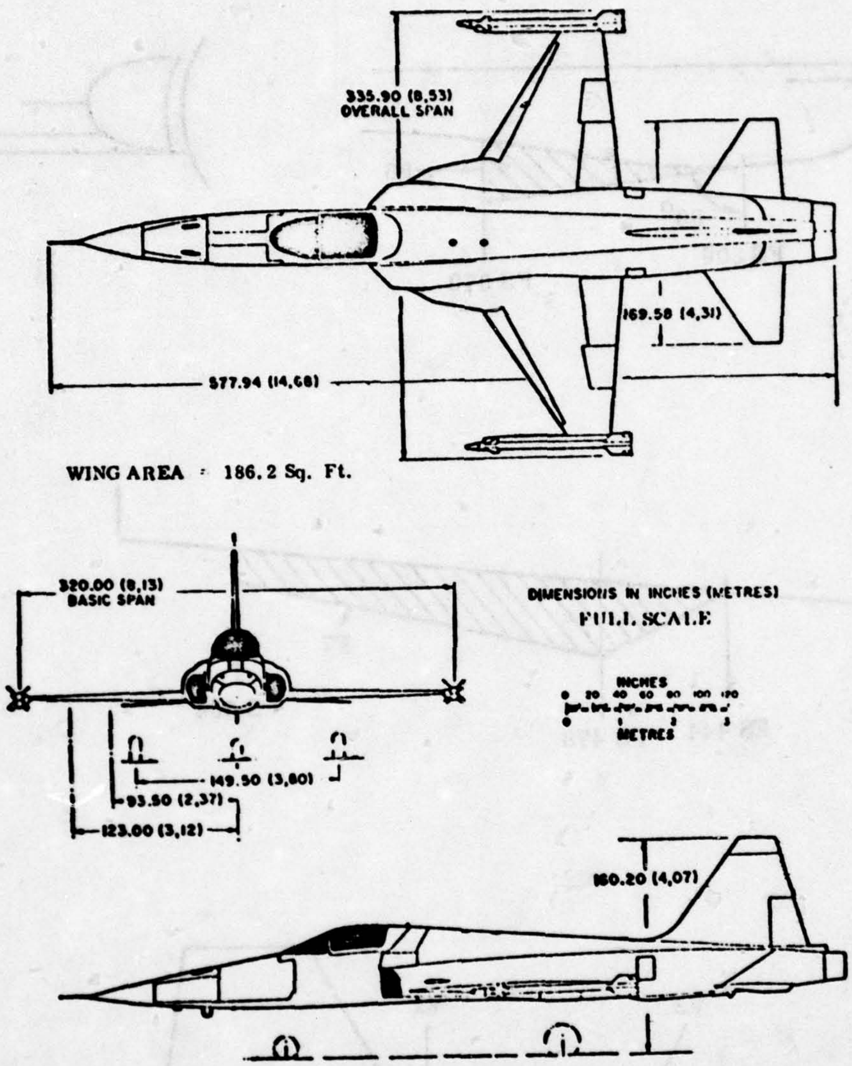
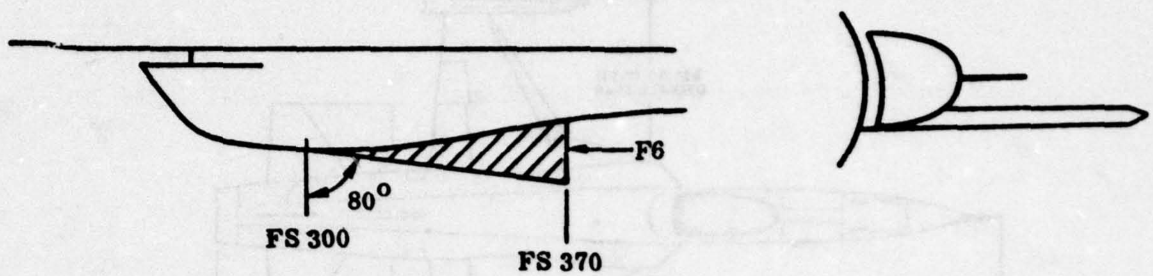
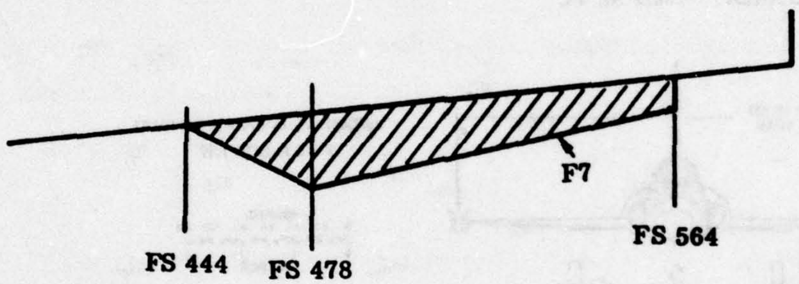


Figure 208. F-5E General Three View

CANARDS



VENTRALS



DORSALS

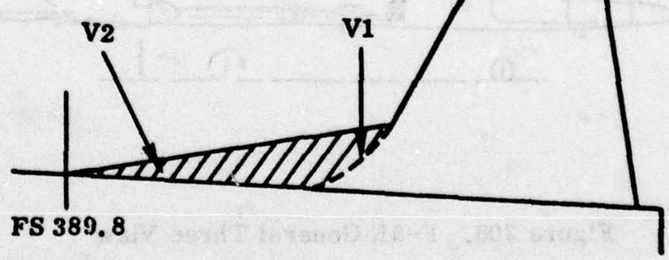


Figure 209. Canard F6, Ventral Fin F7, Dorsals V1, V2

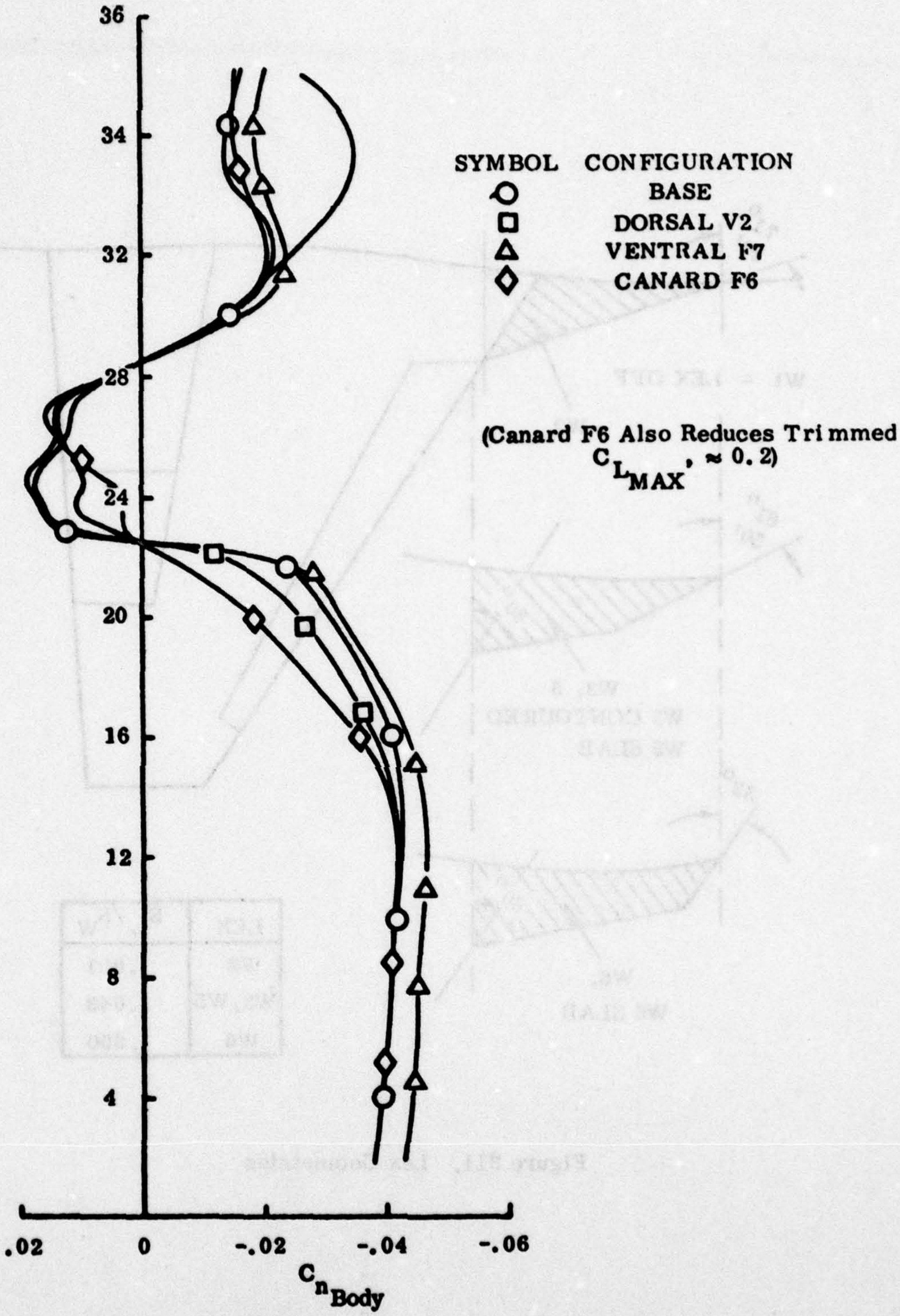
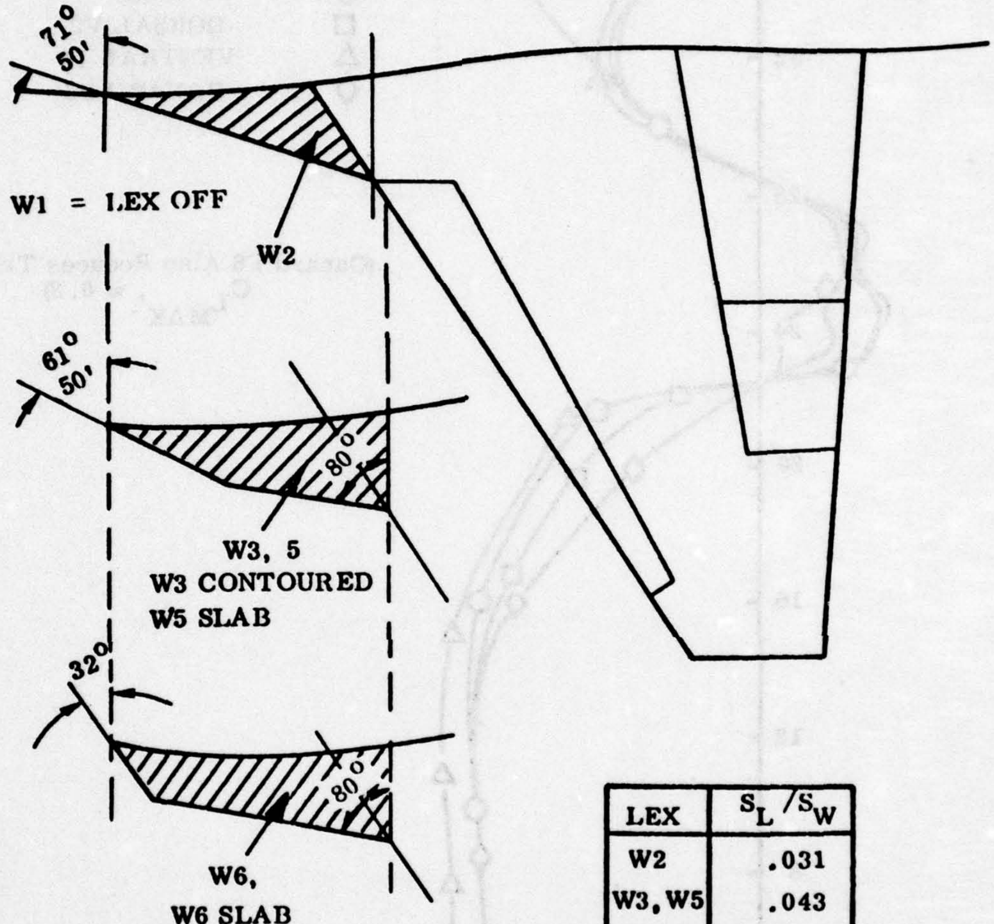


Figure 210. Effect of Dorsal and Ventral Fins and Canards



LEX	S_L / S_W
W2	.031
W3, W5	.043
W6	.050

Figure 211. Lex Geometries

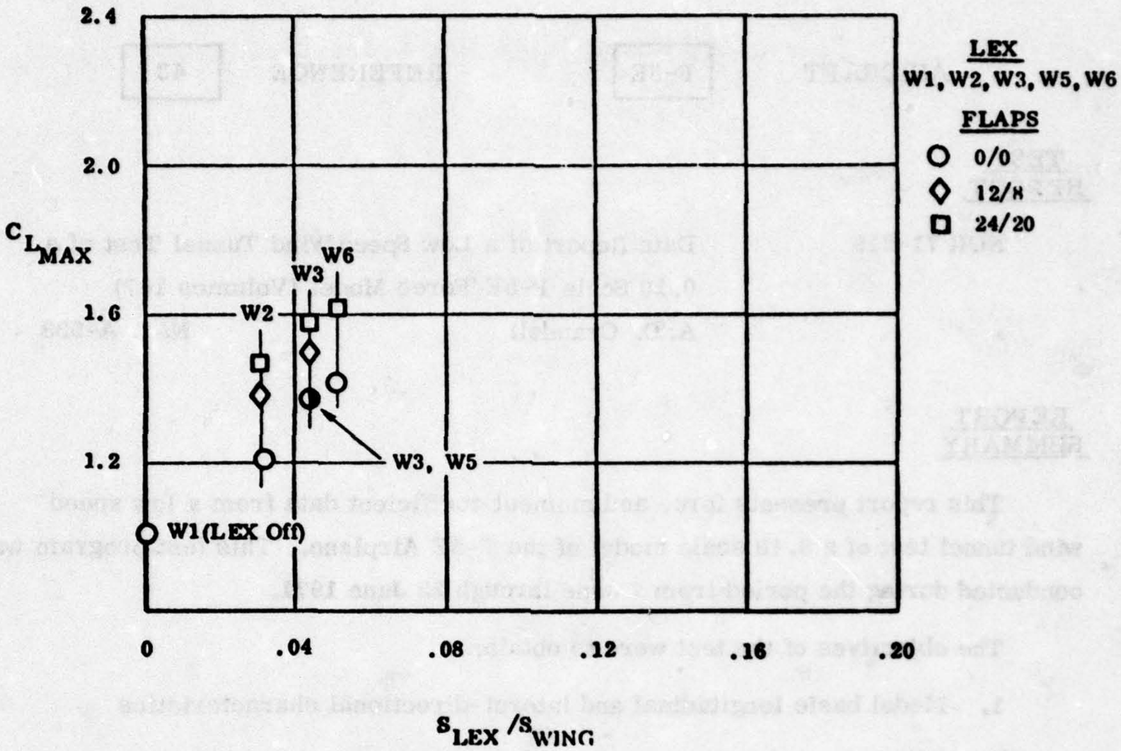


Figure 212. Effect of Lex Area, Lex Airfoil, and Flaps on $C_{L_{MAX}}$

AIRCRAFT	F-5E	REFERENCE	43

TEST REPORT

NOR 71-219 Data Report of a Low Speed Wind Tunnel Test of a 0.10 Scale F-5E Force Model (Volumes 1-7)

A. D. Crandell NAL-A-938

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 0.10 scale model of the F-5E Airplane. This test program was conducted during the period from 7 June through 23 June 1971.

The objectives of the test were to obtain:

1. Model basic longitudinal and lateral-directional characteristics
2. Effect of various wing leading edge extensions
3. Effect of wing leading and trailing edge flap angles
4. Effect of pylons and stores
5. Horizontal tail effectiveness
6. Effect of speed brakes
7. Aileron Effectiveness
8. Rudder Effectiveness
9. Effect of duct-mounted navigation light
10. Horizontal tail loads
11. Store characteristics in free air and on the model

TEST CONDITIONS

Mach No. = 0.28

R. N./Foot = 1.9×10^6

A. O. A. Range = -10 to 40°

Sideslip Range = 0 to -20°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 208.

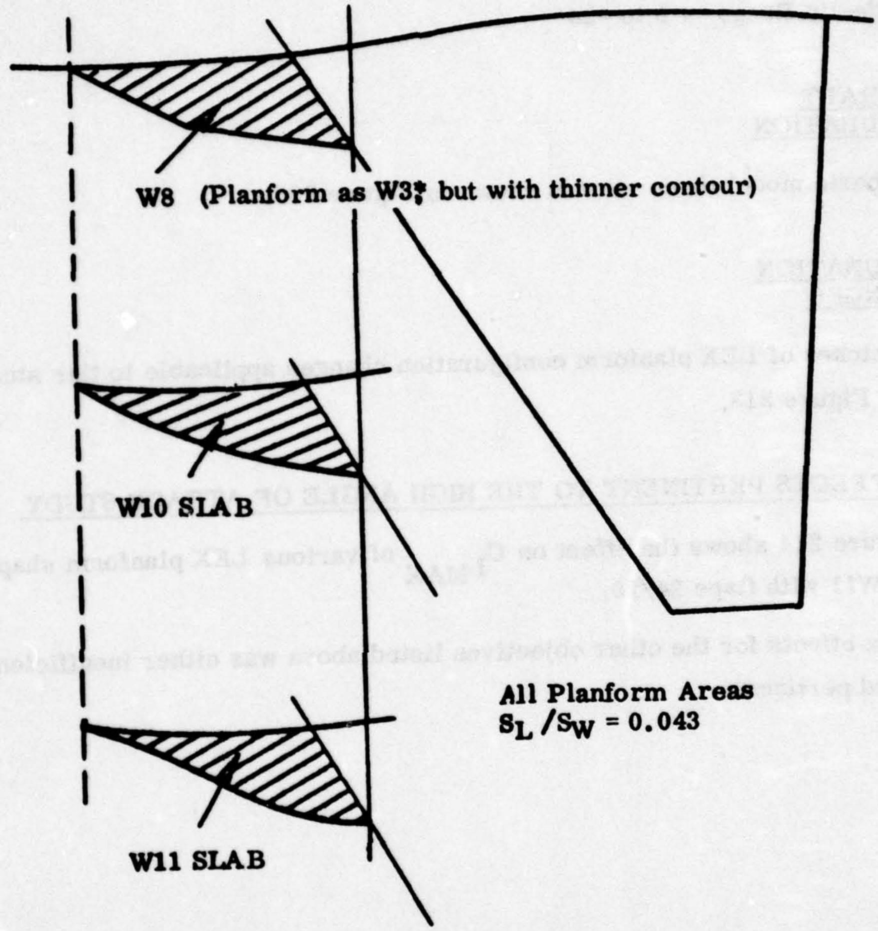
CONFIGURATION CHANGES

Sketches of LEX planform configuration changes applicable to this study are shown in Figure 213.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 214 shows the effect on $C_{L_{MAX}}$ of various LEX planform shapes W8, W10 and W11 with flaps 24/20.

Data effects for the other objectives listed above was either insufficient or not considered pertinent.



*See Figure 211.

Figure 213. Lex Planforms W8, W10, W11

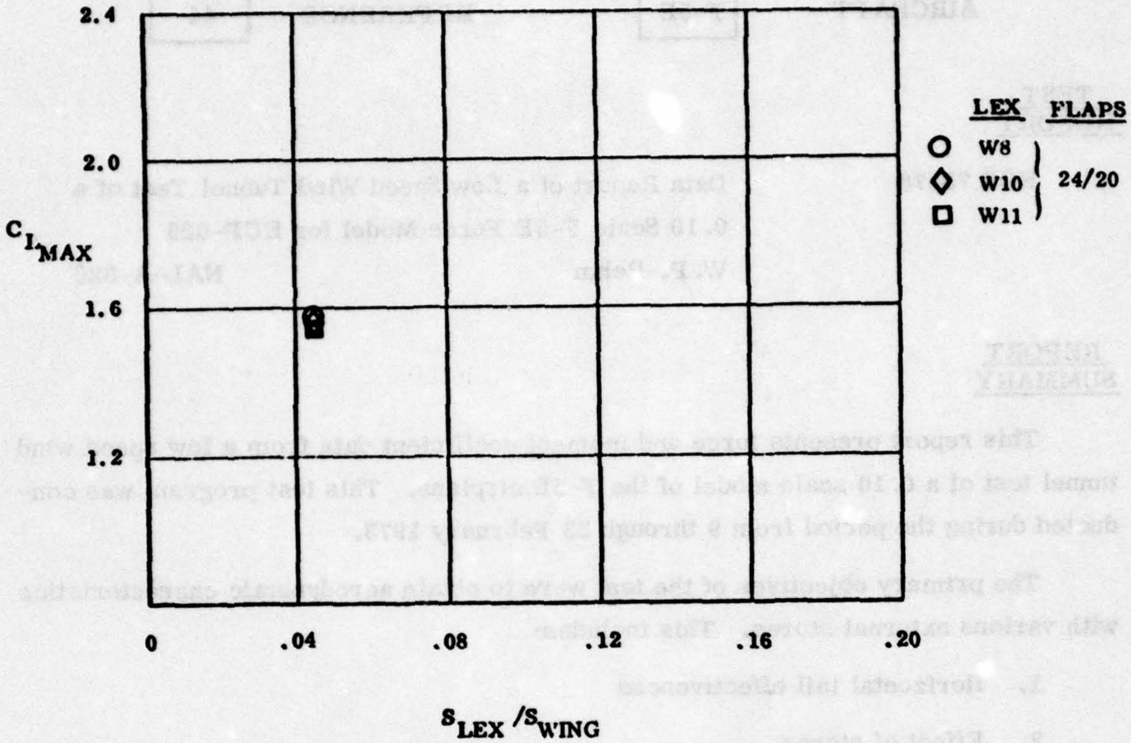


Figure 214. Effect of Lex Planform Shape

AIRCRAFT **F-5E** REFERENCE **44**

TEST REPORT

NOR 73-78

Data Report of a Low Speed Wind Tunnel Test of a 0.10 Scale F-5E Force Model for ECP-025

W. P. Rehm NAL-A-020

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 0.10 scale model of the F-5E airplane. This test program was conducted during the period from 9 through 23 February 1973.

The primary objectives of the test were to obtain aerodynamic characteristics with various external stores. This includes:

1. Horizontal tail effectiveness
2. Effect of stores
3. Lateral-directional characteristics
4. Aileron effectiveness
5. Horizontal tail loads
6. High attitude characteristics
7. External store loads

The secondary objectives of the test were to obtain:

1. Effect of duct inlet cowl
2. Effect of partially and fully extended landing gear
3. Effect of wing trailing edge flap gap

TEST
CONDITIONS

Mach No.	=	0.25 - 0.28
R.N./Foot	=	$1.7 - 1.9 \times 10^6$
A.O.A. Range	=	-10° to 40°
Sideslip Range	=	0 to -20°

AIRCRAFT
CONFIGURATION

A basic model three view is shown in Figure 208.

CONFIGURATION
CHANGES

Sketches of canard and duct cowl configuration changes applicable to this study are shown in Figures 215 and 216.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 217 shows the effect on $C_{L_{MAX}}$ of duct cowls D2 and D3 and canard D5.

Figures 218 and 219 shows the effect on pitch data and lateral/directional stability of duct cowl D2. Similar effects are shown in Figures 220 and 221 for duct cowls D3, D4, and D5.

Data effects for primary objectives 1 through 7 and secondary objective 2 listed above was not considered pertinent.

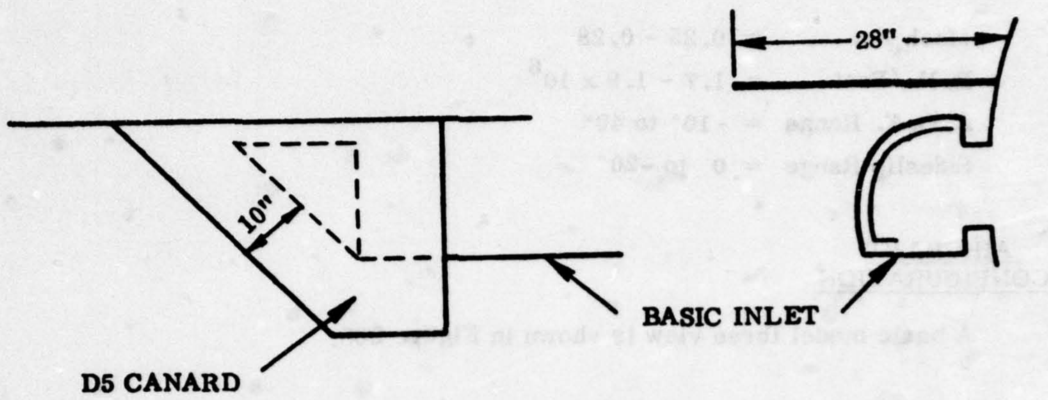
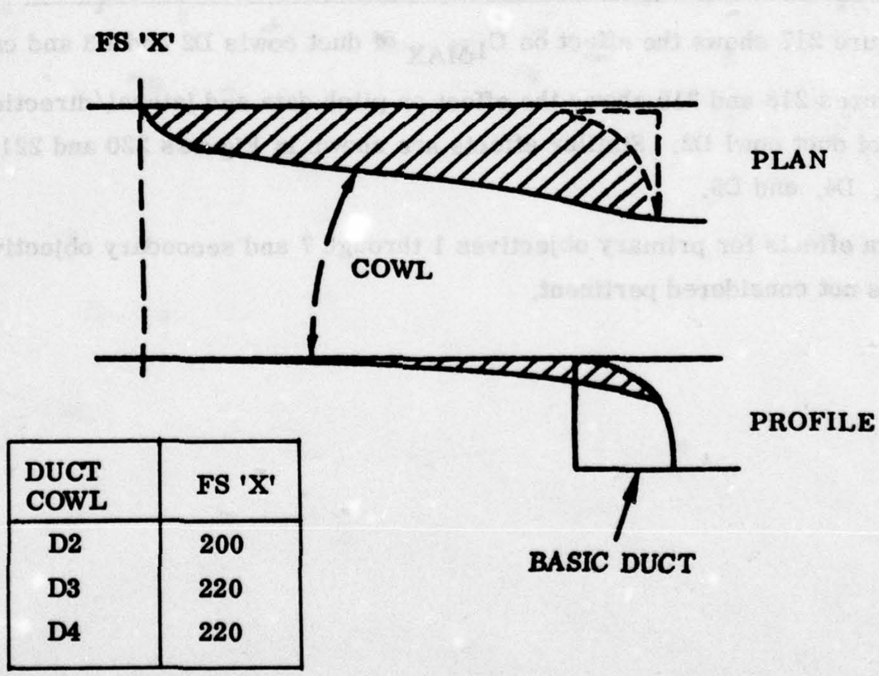


Figure 215. Canard Geometry, D5



DUCT COWL	FS 'X'
D2	200
D3	220
D4	220

Figure 216. Duct Cowls (D2, D3, D4)

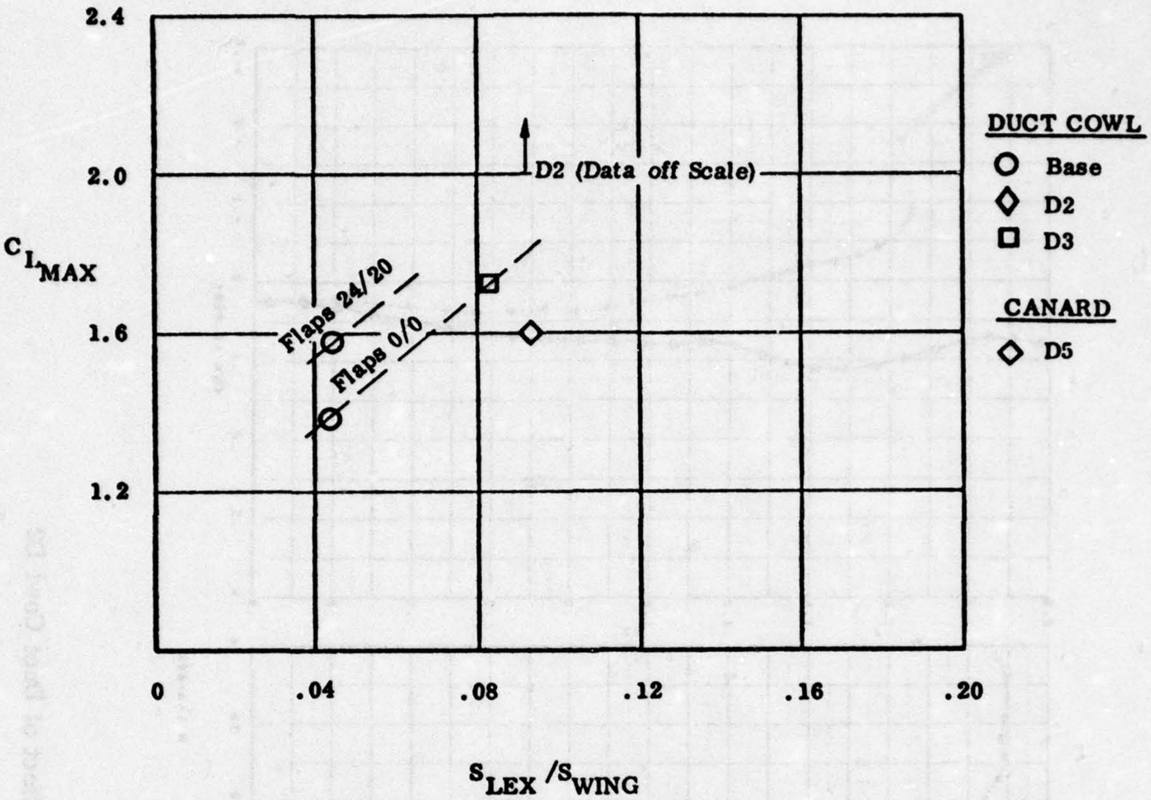


Figure 217. Effect of Duct Cowls and Canard D5 on $C_{L_{MAX}}$

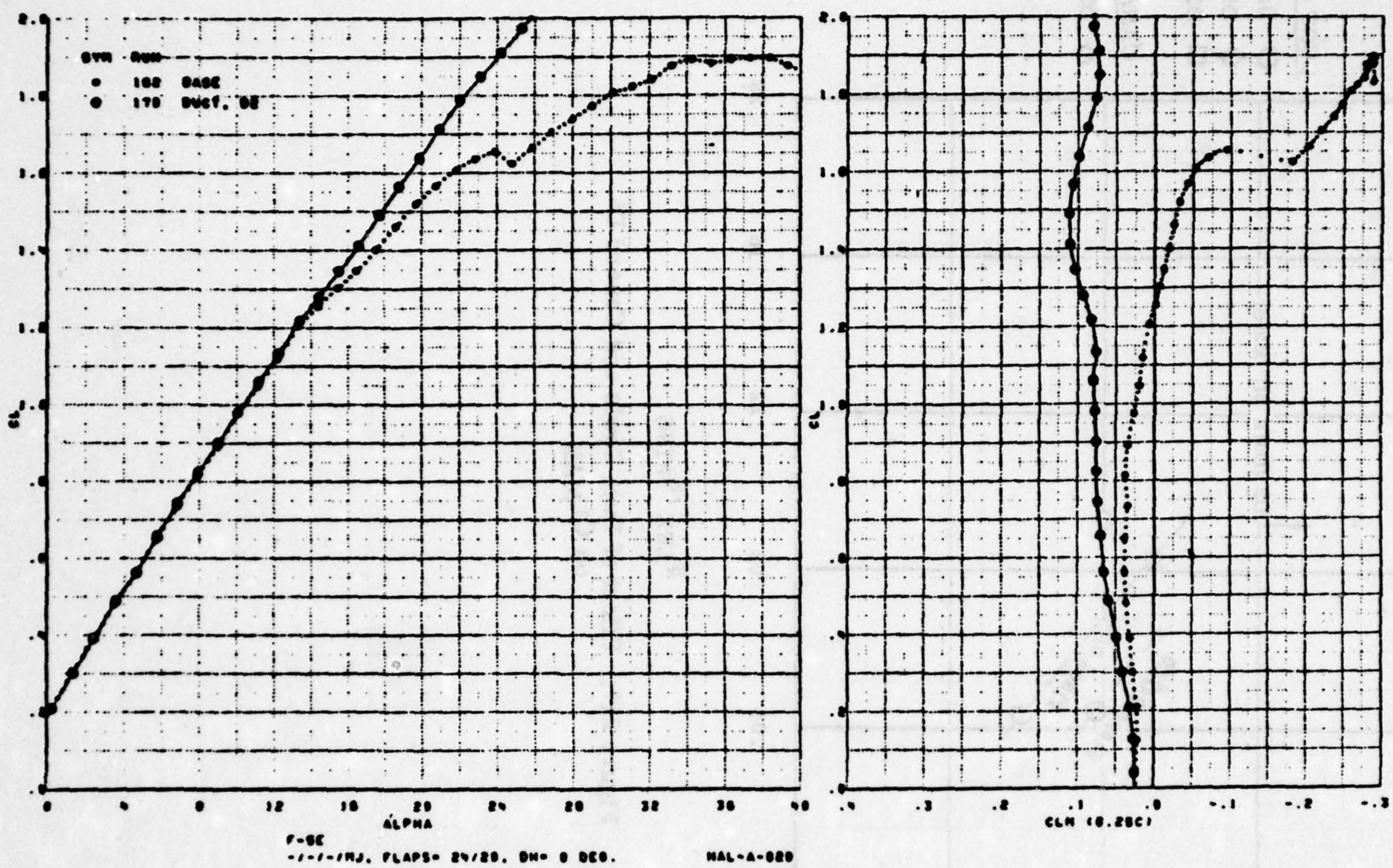


Figure 218. Effect of Duct Cowl D2

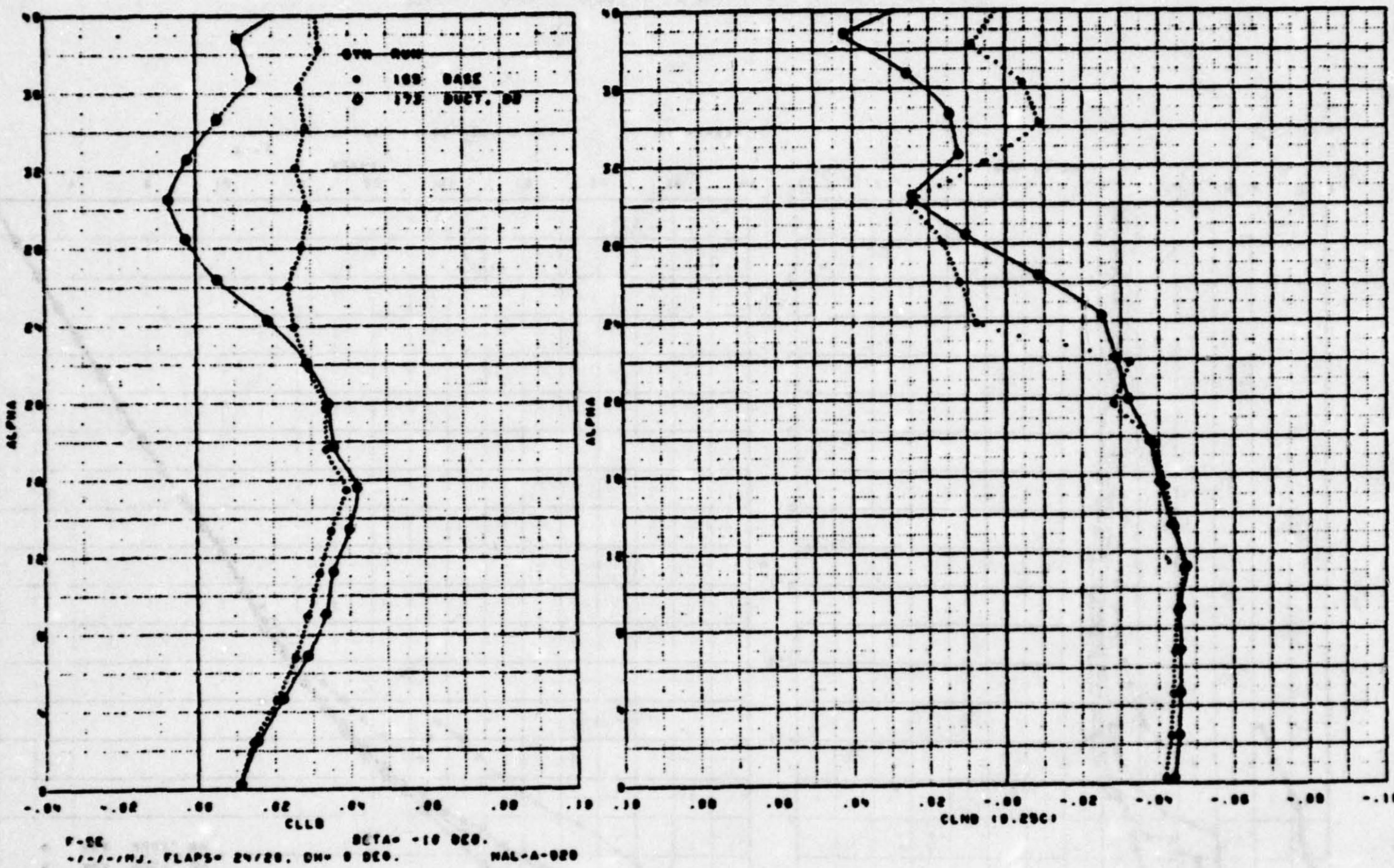


Figure 219. Effect of Duct Cowl D2

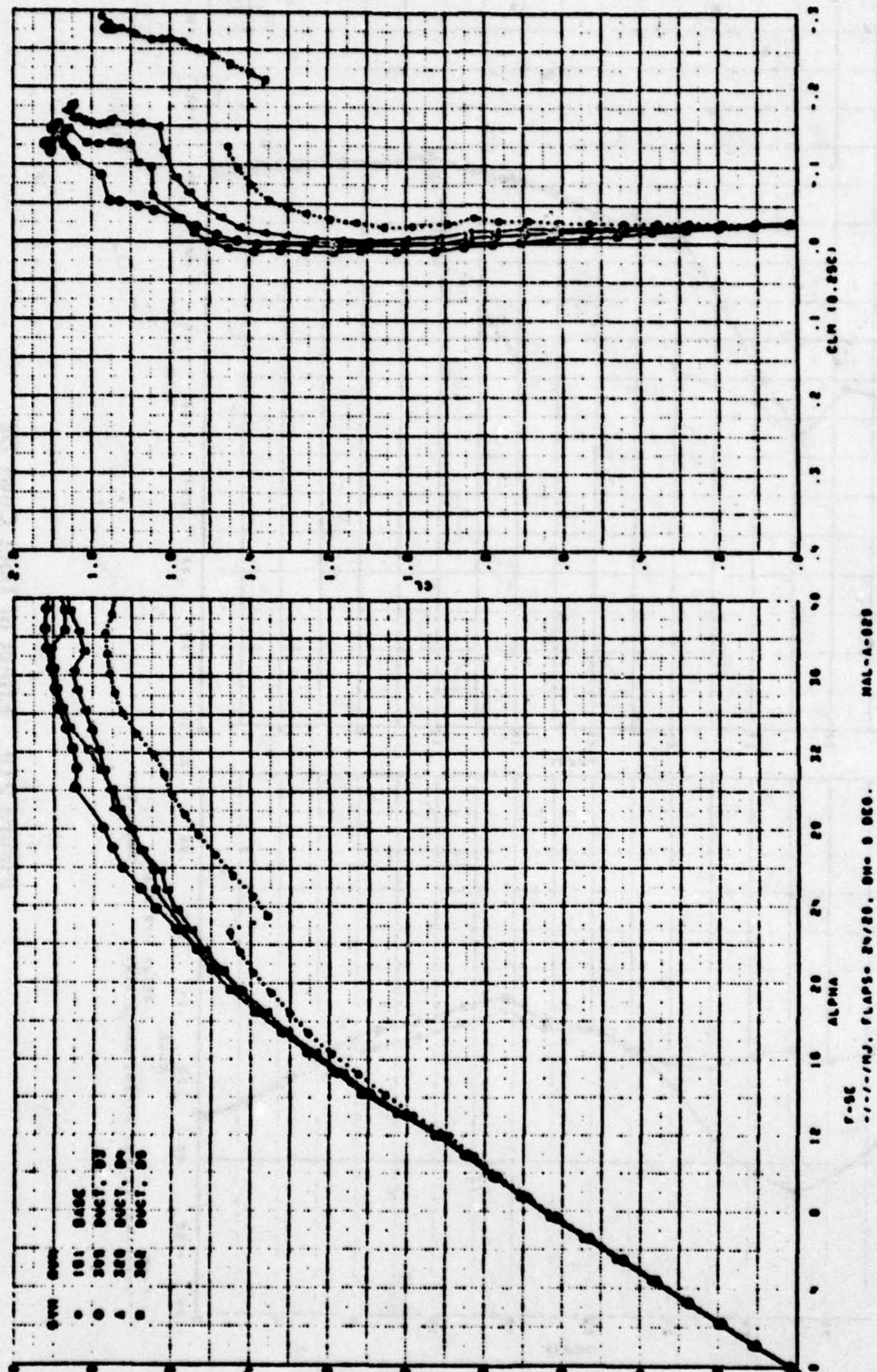


Figure 220. Effect of Duct Cowls D3, D4, D5

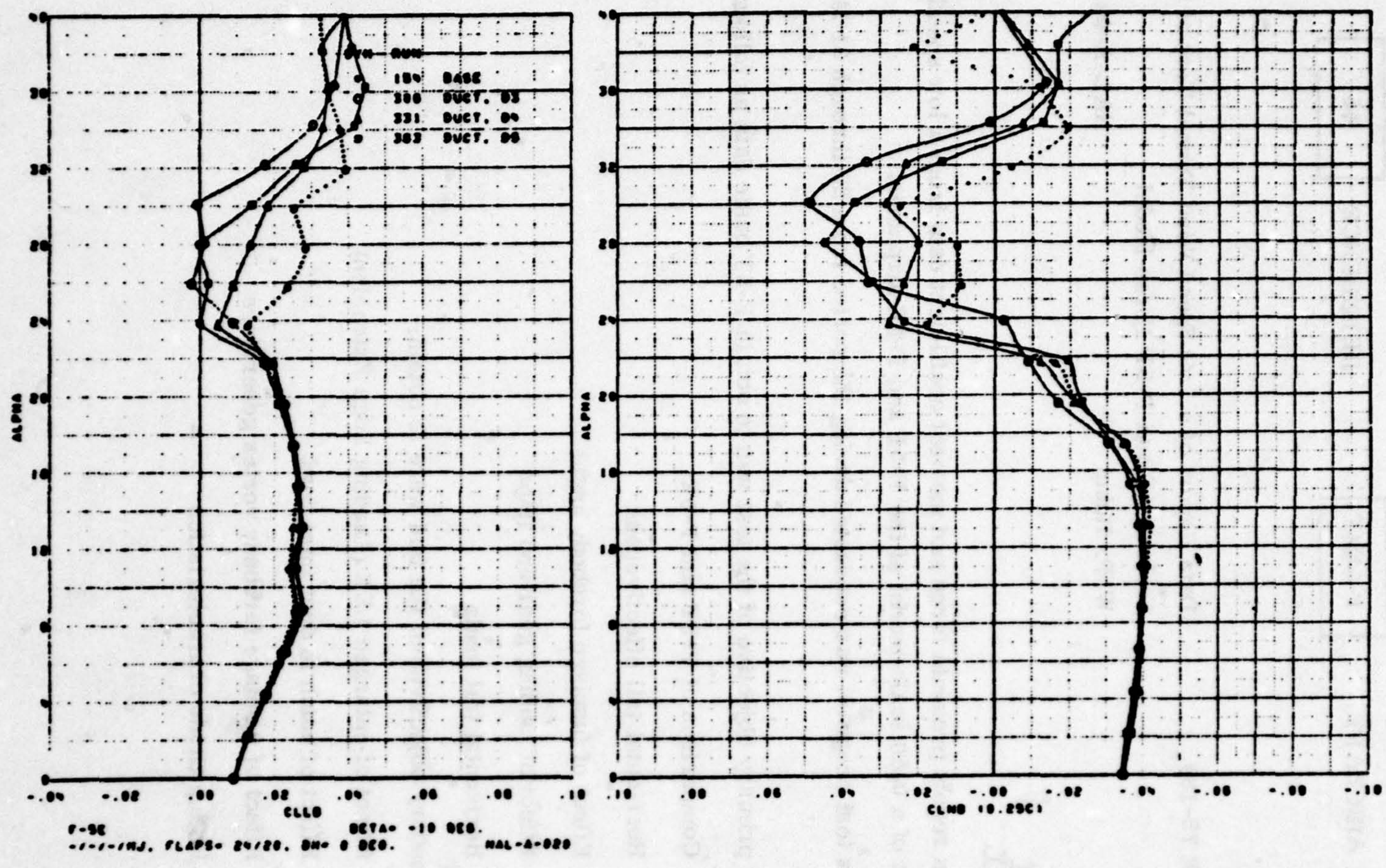


Figure 221. Effect of Duct Cowls D3, D4, D5

AIRCRAFT | F-5E/F | REFERENCE | 45

TEST REPORT

NOR 73-189 — Data Report of a Low Speed Wind Tunnel Test of a 0.10 Scale F-5E and F-5F Force Model

W. P. Rehm — NAL-A-033

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 0.10 scale model of the F-5F and F-5E airplanes.

This test program was conducted during the period from 25 through 31 May 1973.

The primary objective of the test was to obtain F-5F basic data as follows:

1. Comparison of F-5F and F-5E
2. Horizontal tail effectiveness
3. Effect of fuselage forebody angle
4. Effect of landing gear and flaps
5. Horizontal tail loads

Secondary objectives of the test were to obtain:

1. Effect of enlarged LEX (Leading Edge Extension)
2. Effect of notch in duct inlet cowl
3. Effect of fuselage forebody vortex generators
4. High attitude characteristics

TEST CONDITIONS

Mach No.	=	0.25 - 0.28
R.N./Foot	=	$1.7 - 1.9 \times 10^6$
A.O.A. Range	=	-10° to 40°
Sideslip Range	=	0° to -20°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figures 208.

CONFIGURATION CHANGES

Sketches of LEX, inlet notch and fuselage vortex generator configuration changes applicable to this study are shown in Figures 223, 225 and 228.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 224 shows the effect of $C_{L_{MAX}}$ of LEX planform W8 and W12.

Figures 226 and 228 show the effect on pitch data and lateral/directional stability of inlet duct notch, D6.

Figures 229 and 230 show similar effects for fuselage vortex generator location (m2, m3) and (m4, M5), and vortex generator size, (m2, m4) and (m3, m5).

Data effects for primary objectives 1 through 5 listed above was not considered pertinent.

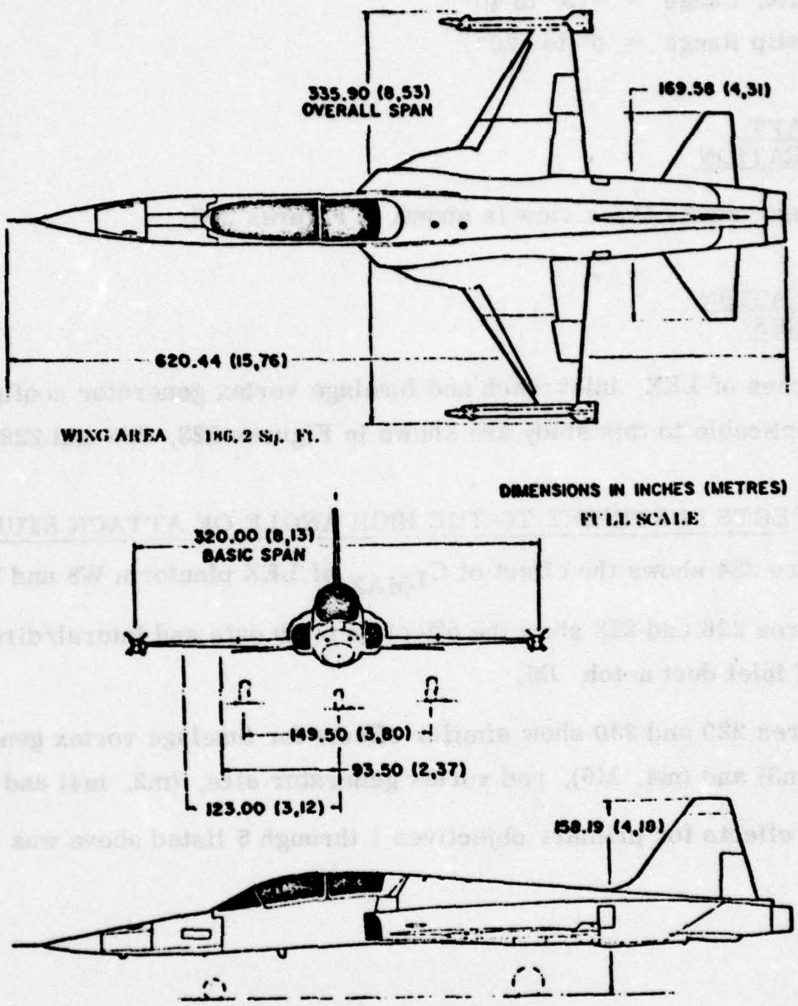
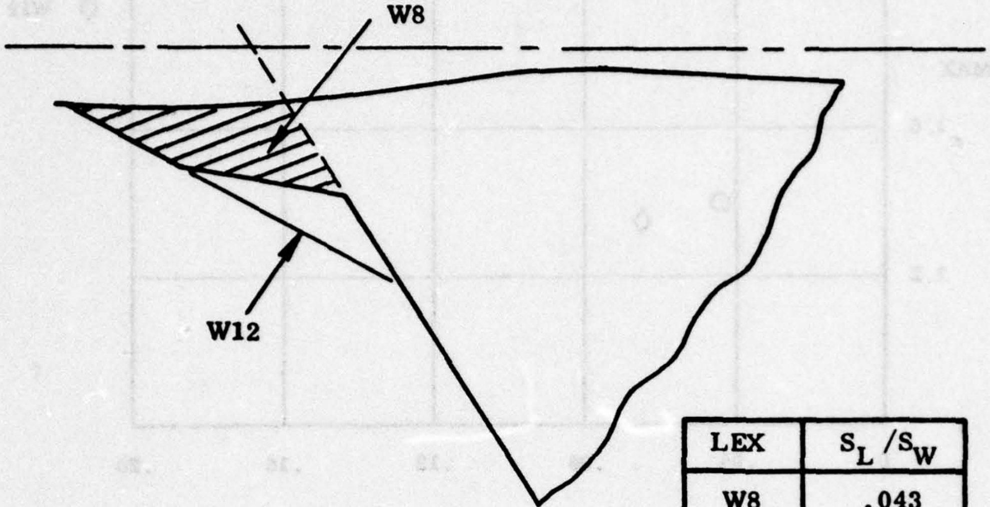


Figure 222. F-5F General Three View



LEX	S_L / S_W
W8	.043
W12	.064

Figure 223. Lex Geometry W8, W12

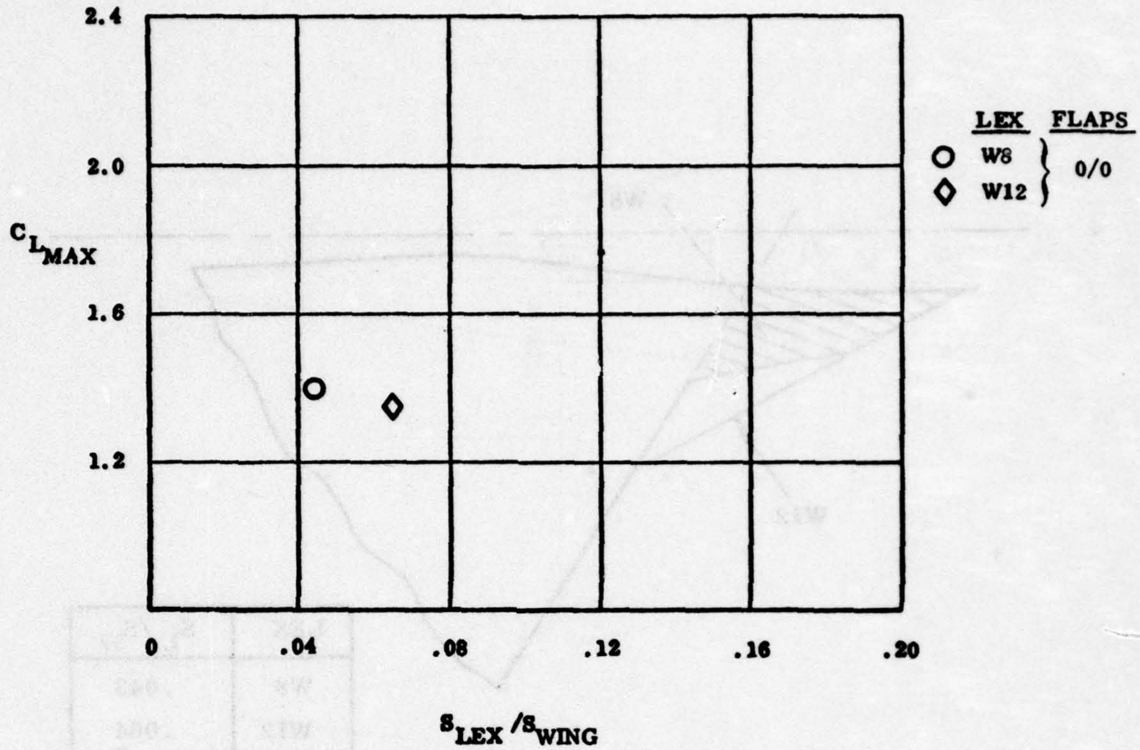


Figure 224. Effect of Lex Planform on $C_{L_{MAX}}$

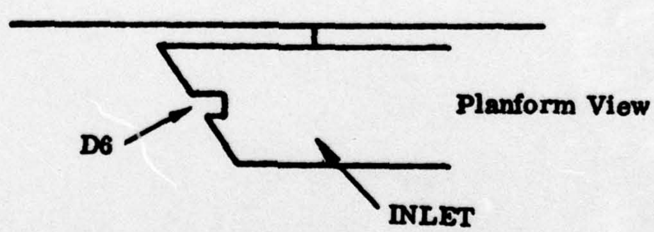


Figure 225. Inlet Notch D6

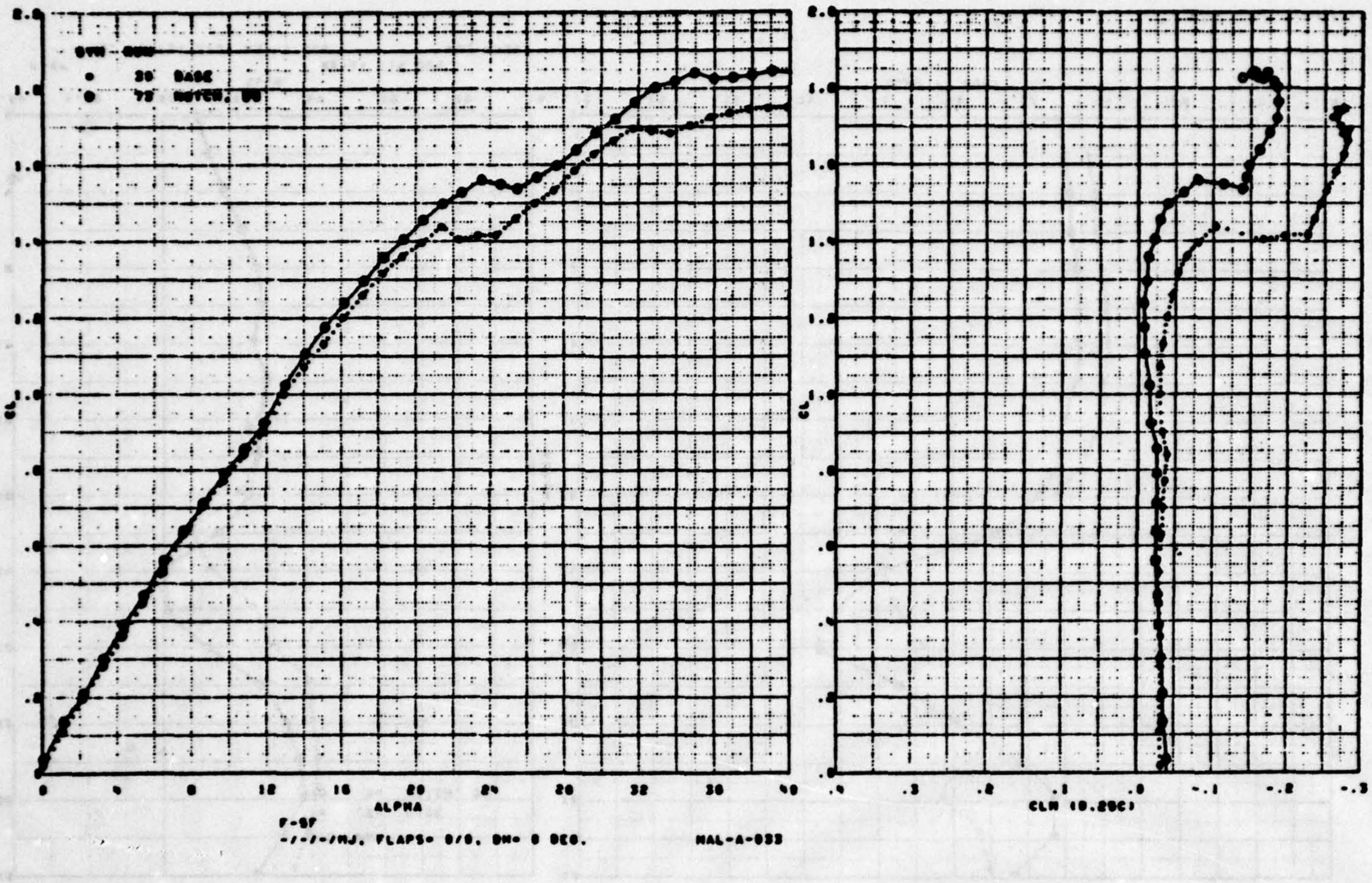


Figure 226. Effect of Inlet Notch, D6

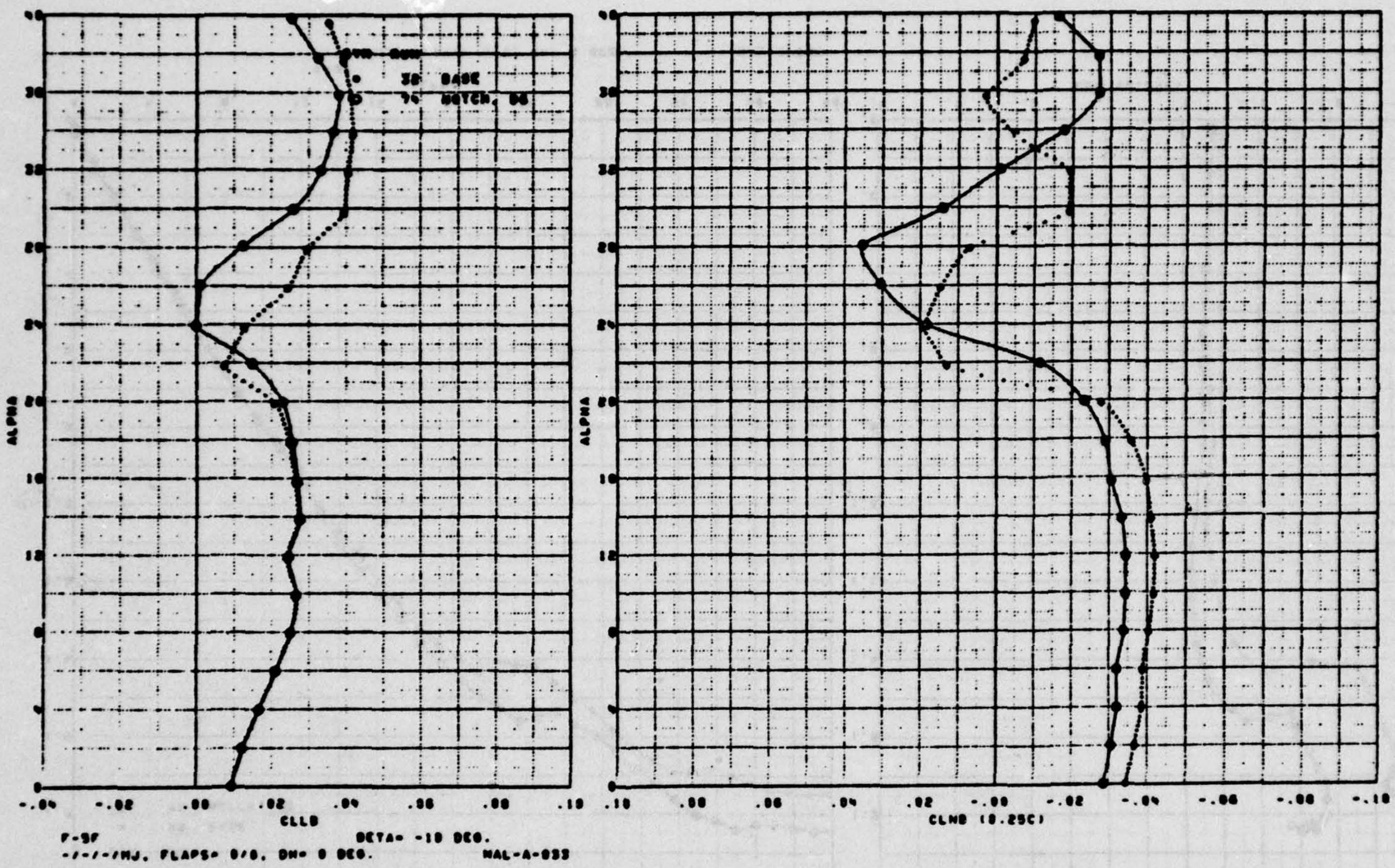


Figure 227. Effect of Inlet Notch, D6

Variation in Location (m2, 3)(m4, 5)

Variation of Size (m2, 4)(m3, 5)

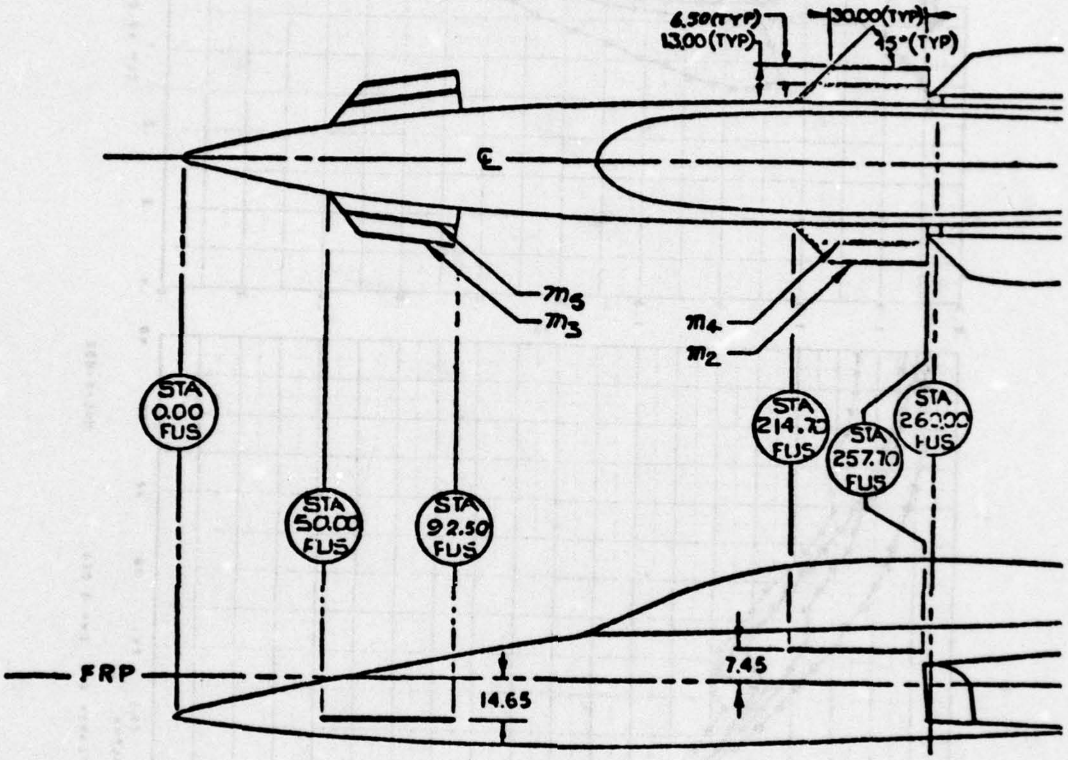


Figure 228. Fuselage Vortex Generators

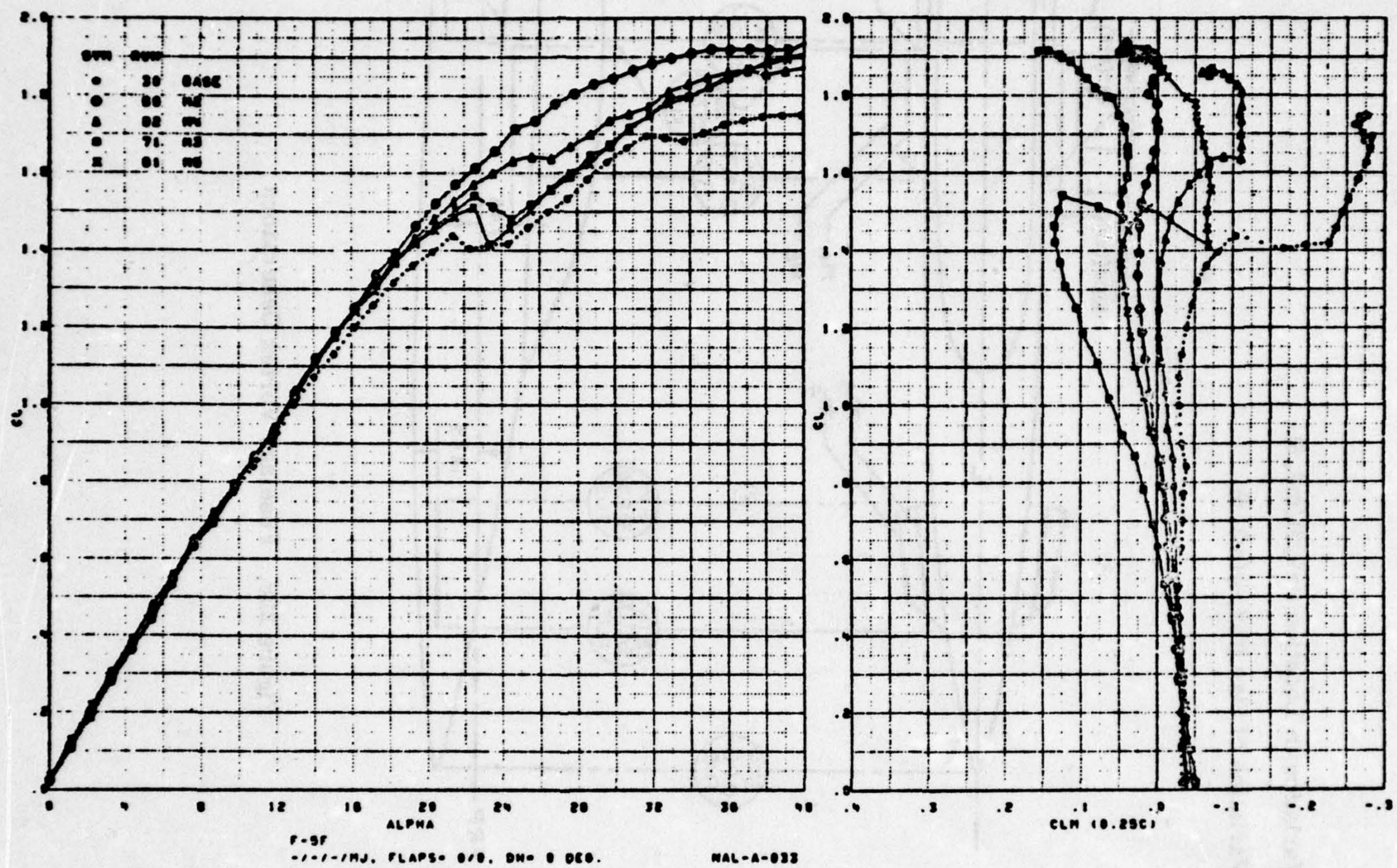


Figure 229. Effect of Vortex Generators

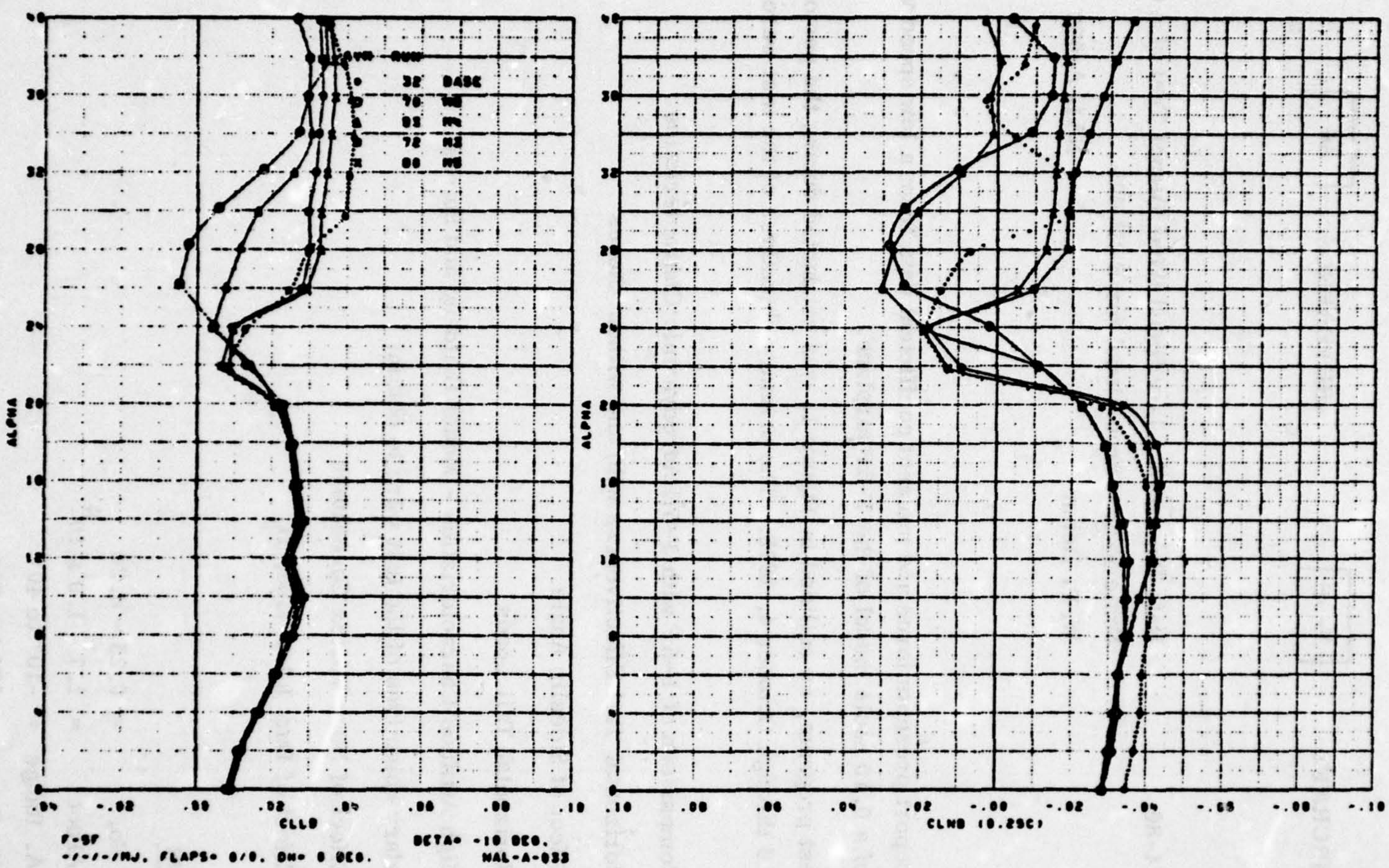


Figure 230. Effect of Vortex Generators

AIRCRAFT **F-5E** REFERENCE **46**

TEST REPORT

NOR 74-86 Data Report of a Low Speed Wind Tunnel Test of a 0.10 Scale F-5E Force Model for ECP-025

W. P. Rehm NAL-A-062

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 0.10 scale model of the F-5F airplane.

The test program, as outlined in Figure 1, was conducted during the period from September 10 through October 4, 1973. The primary objectives of the test were to obtain:

1. Comparison of F-5F with F-5E Aerodynamic Characteristics
2. Horizontal Tail Effectiveness with and without Stores
3. Effect of Sideslip Angle
4. Horizontal Tail Loads
5. High Attitude Characteristics - Model Build-up and Stores

Secondary objectives of the test were to obtain:

1. Effect of Nose Vortex Generators
2. Effect of Duct Inlet Hood, D_5

TEST CONDITIONS

Mach No. = 0.25 - 0.28

R. N./Foot = $1.7 - 1.9 \times 10^6$

A.O.A. Range = -10° to 40°

Sideslip Range = 10° to -30°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figures 208 and 222.

CONFIGURATION CHANGES

Sketches of vortex generator configuration changes applicable to this study are shown in Figure 231.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figures 232 and 233 show the effect on pitch data and lateral/directional stability of vortex generator location m5, m7 and m8. Similar effects are shown in Figures 234 through 235 for vortex generator shape, m5 and m6, and vortex generator angle m5, m9 and m10.

Data Effects for the primary objectives listed above was not considered pertinent.

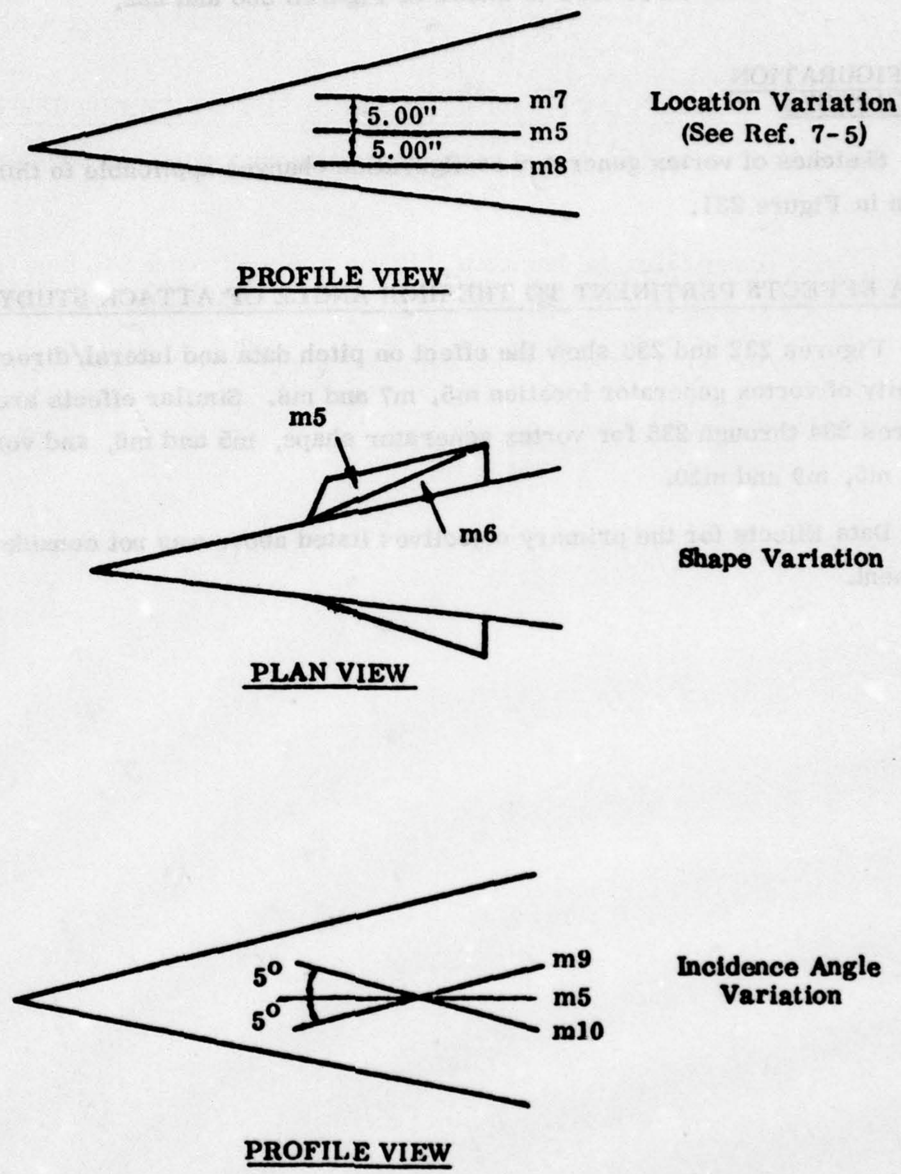


Figure 231. Fuselage Vortex Generators, m5-m10

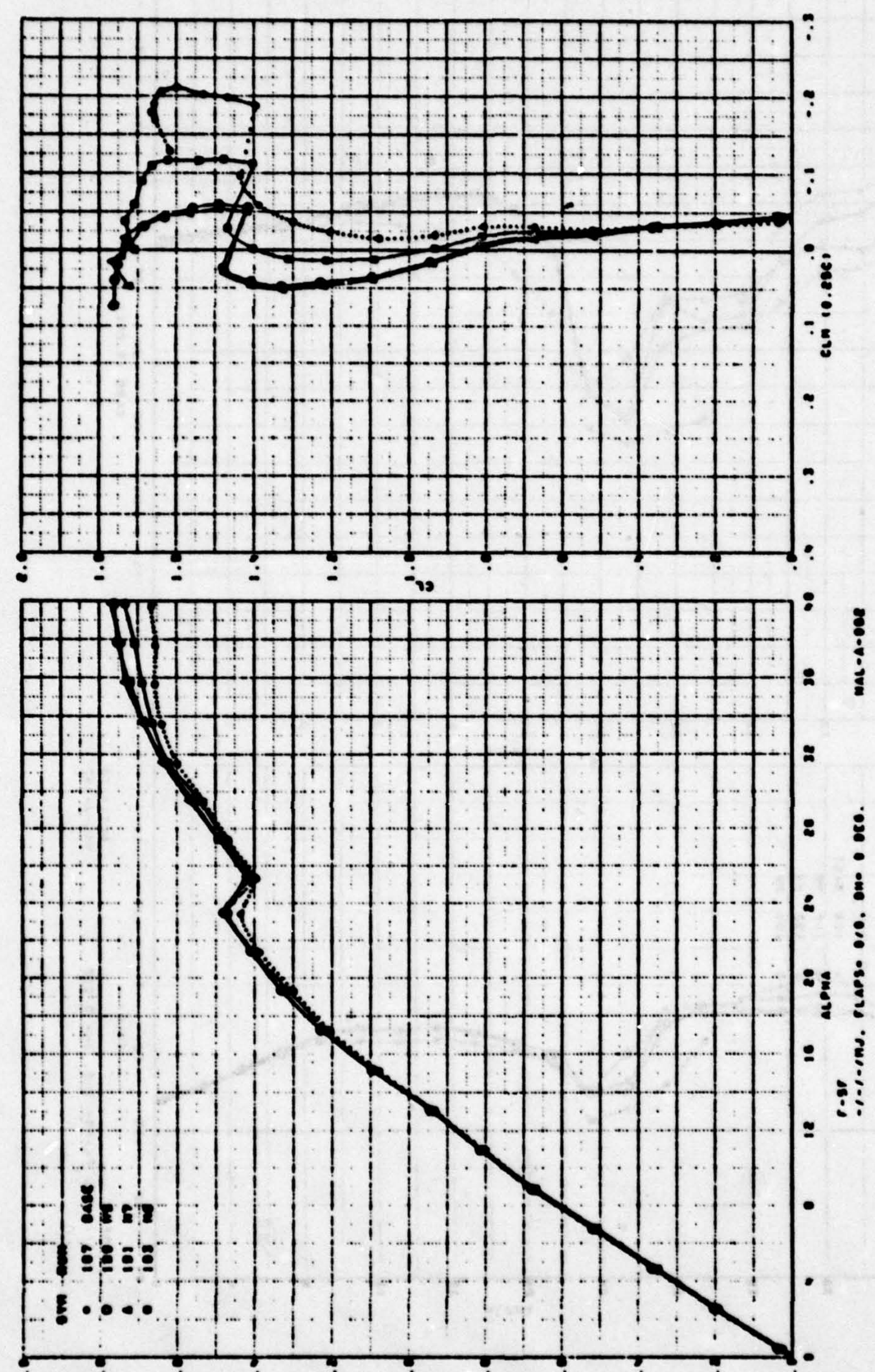


Figure 232. Effect of Vortex Generator Location

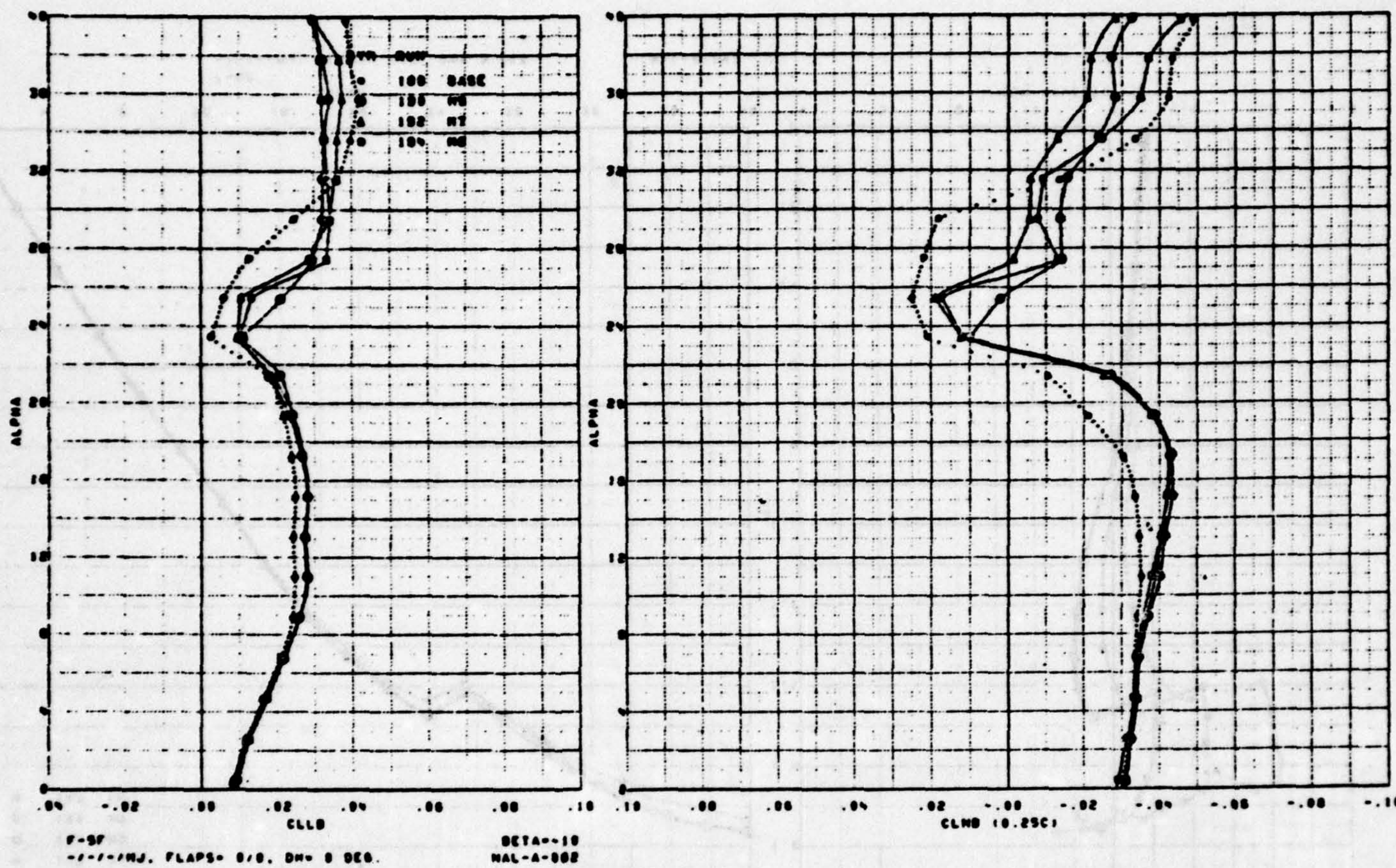


Figure 233. Effect of Vortex Generator Location

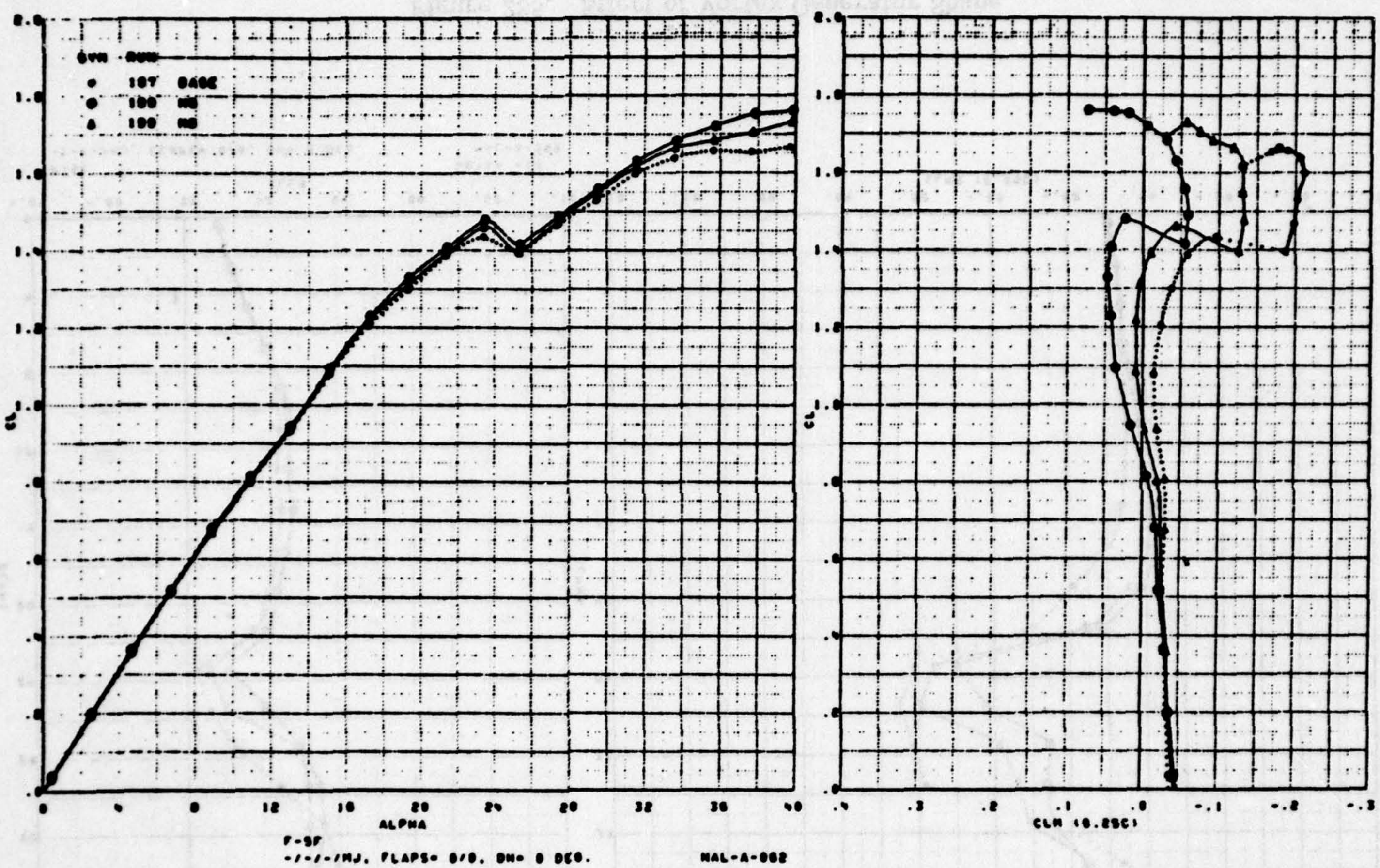


Figure 234. Effect of Vortex Generator Shape

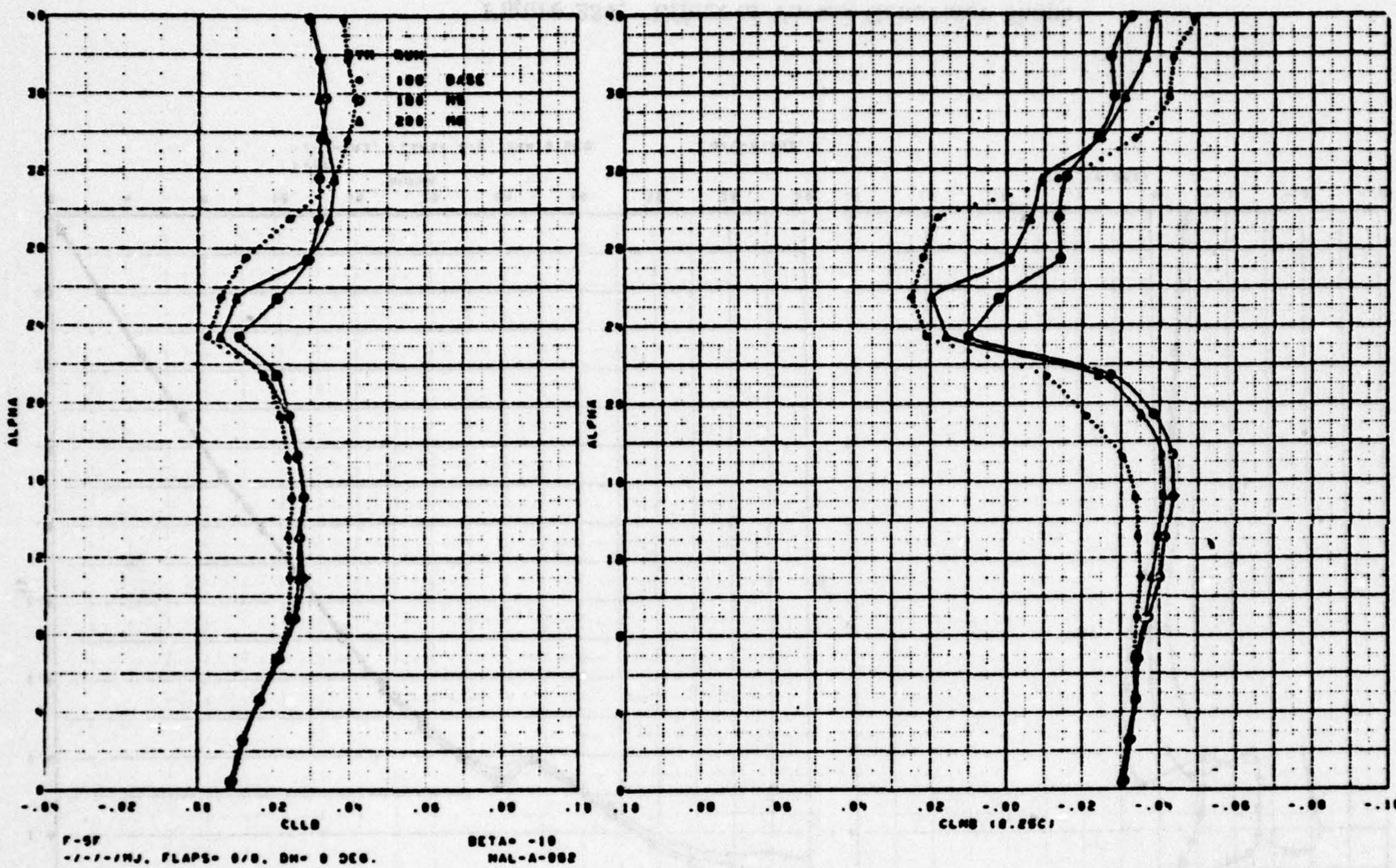


Figure 235. Effect of Vortex Generator Shape

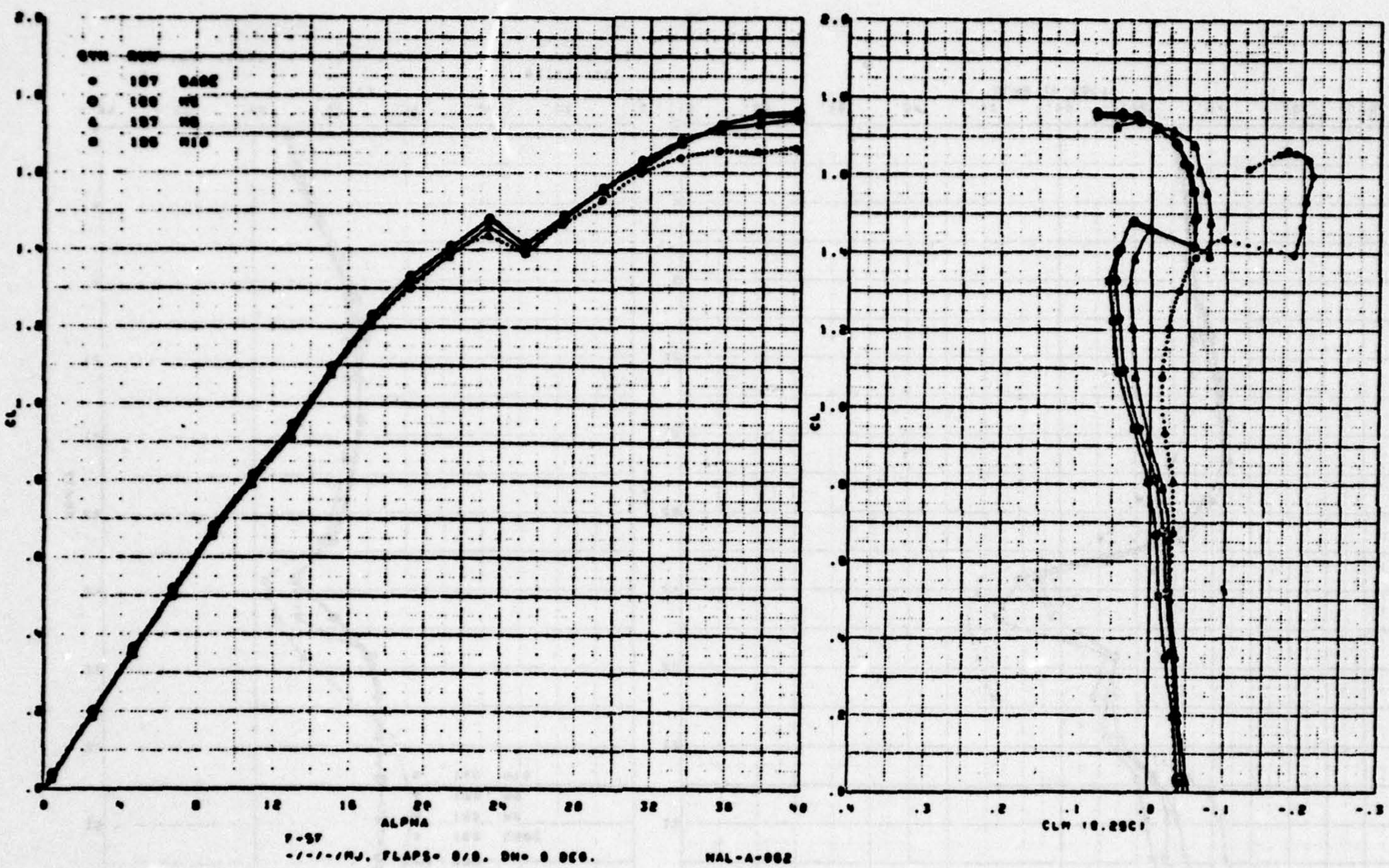


Figure 236. Effect of Vortex Generator Angle

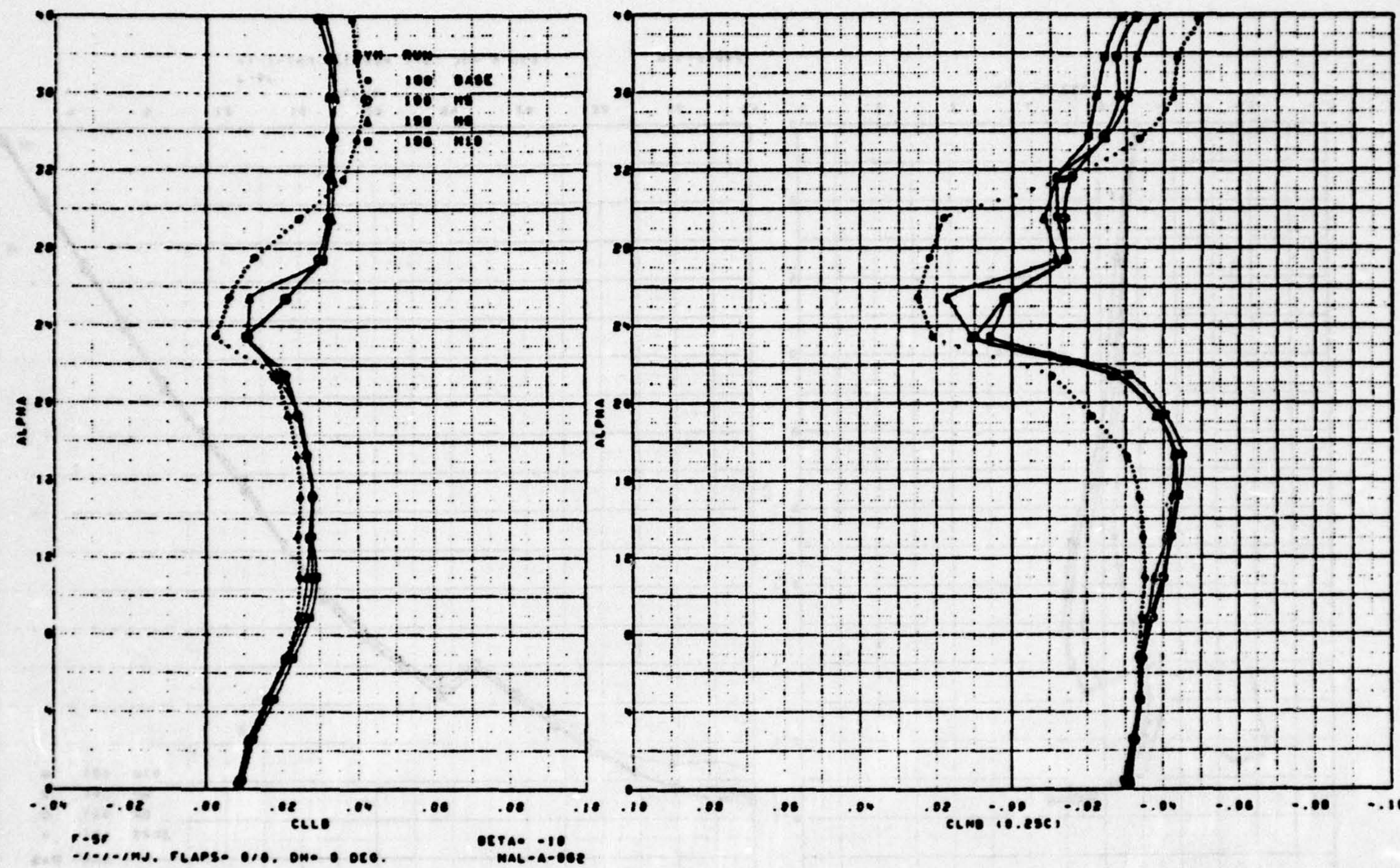


Figure 237. Effect of Vortex Generator Angle

AIRCRAFT **F-5E** REFERENCE **47**

TEST REPORT

NOR 75-136 Data Report of a Low Speed Wind Tunnel Test of a 0.10 Scale F-5E Force Model at Negative Angles of Attack

G. B. Bennett NAL-A-086

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 0.10 scale model of the F-5E airplane. This test program was conducted during the periods from June 4 through June 9 and July 2 through July 9, 1974.

The primary objective of the test was to obtain longitudinal stability trends at negative angles of attack with various wing fences and LEX modifications. Selected configurations were tested in the positive angle of attack range also. Also determined were:

1. Effect of stores
2. Lateral-Directional Characteristics
3. Wing flow characteristics with oil flow visualization/photography

TEST CONDITIONS

Mach No. = 0.28
R. N./Foot = 1.9×10^6
A.O.A. Range = -10° to 40°
Sideslip Range = -10° to 20°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 208.

CONFIGURATION CHANGES

Sketches of wing fence and nose strake configuration changes applicable to this study are shown in Figures 238 and 240.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figures 239 shows the effect on pitch data of the upper surface wing fence, m23.

Figures 241 and 244 show the effect on pitch data and lateral/directional stability of nose strakes, S1 and S2.

Data effects for the primary objectives listed above was not considered pertinent.

FENCE	LOCATION	HEIGHT	LENGTH
m23	WS 76.00	5.00''	100%c

Figure 238. Upper Surface Wing Fence, m23

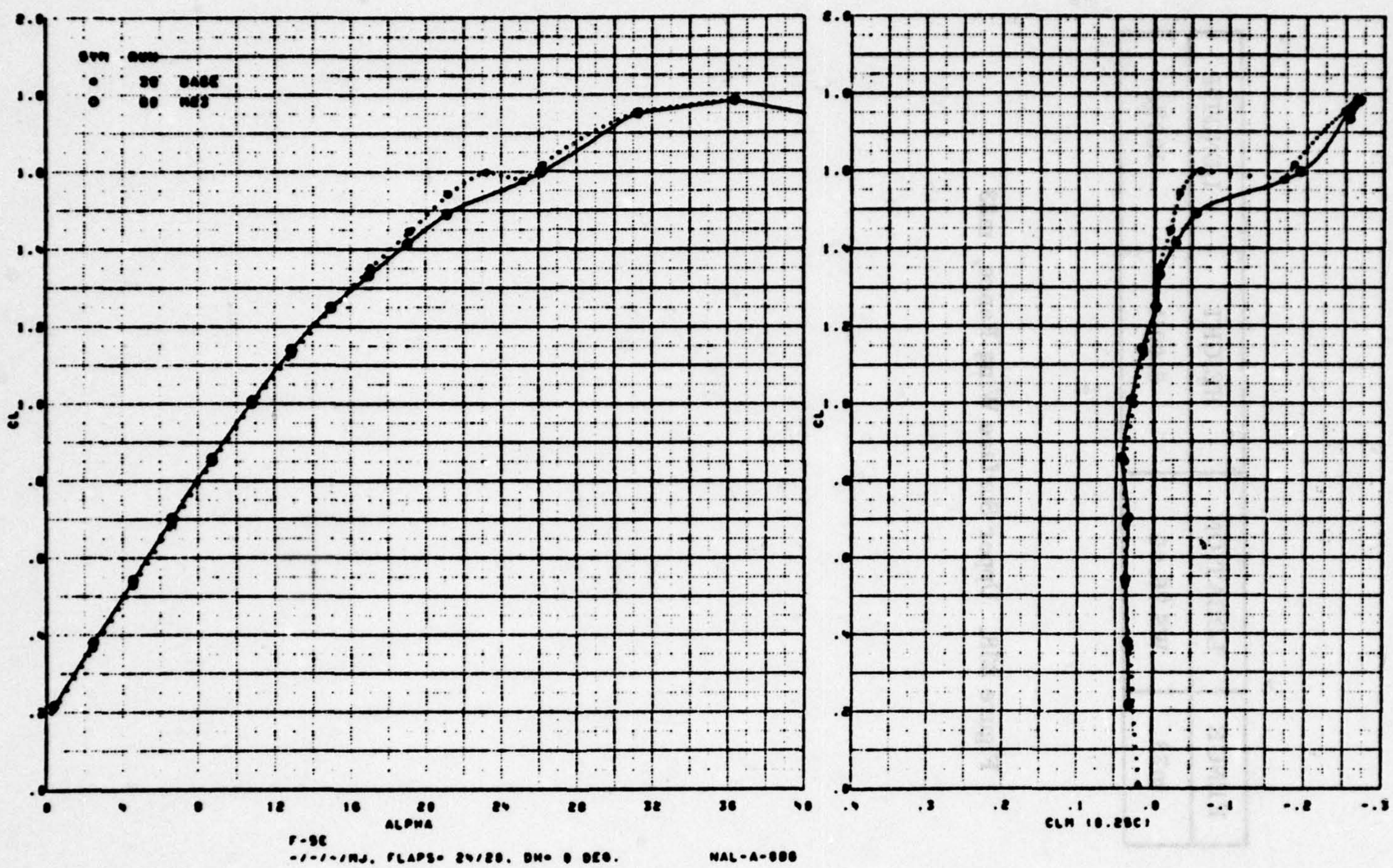


Figure 239. Effect of Upper Surface Wing Fence, m23

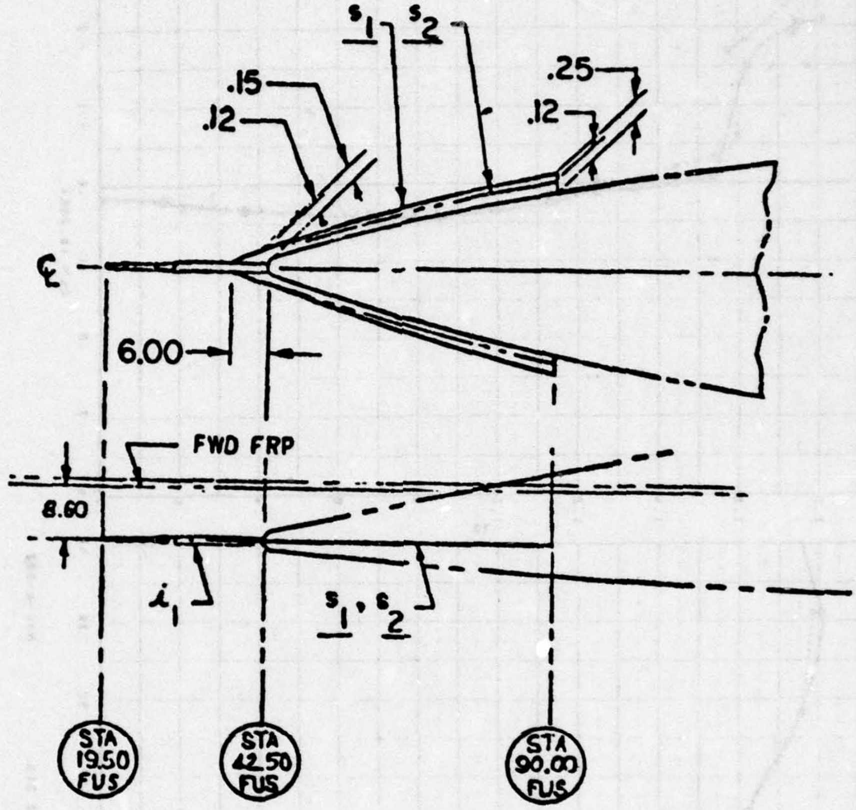


Figure 240. Nose Strakes S1, S2

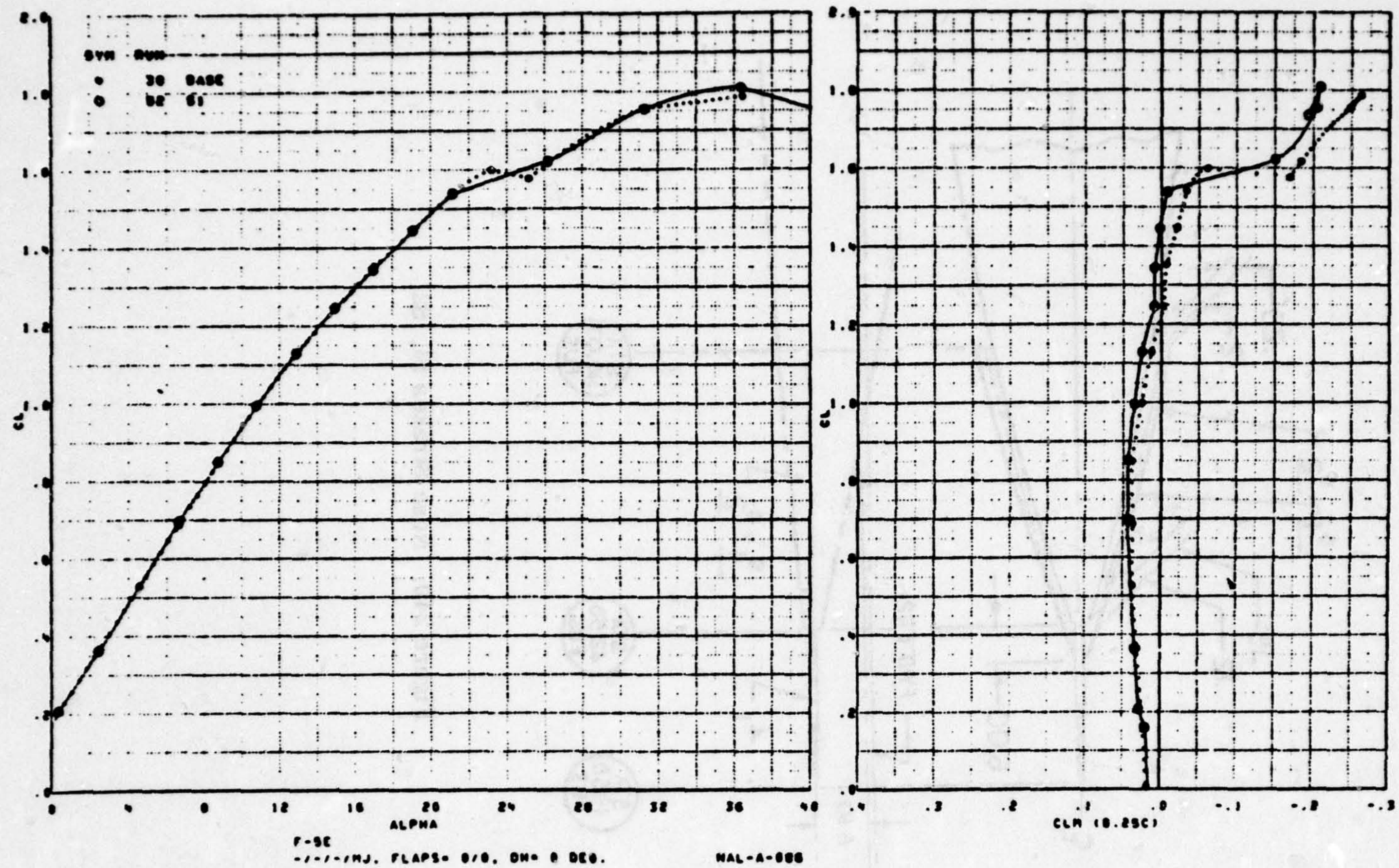


Figure 241. Effect of Nose Strakes, S1

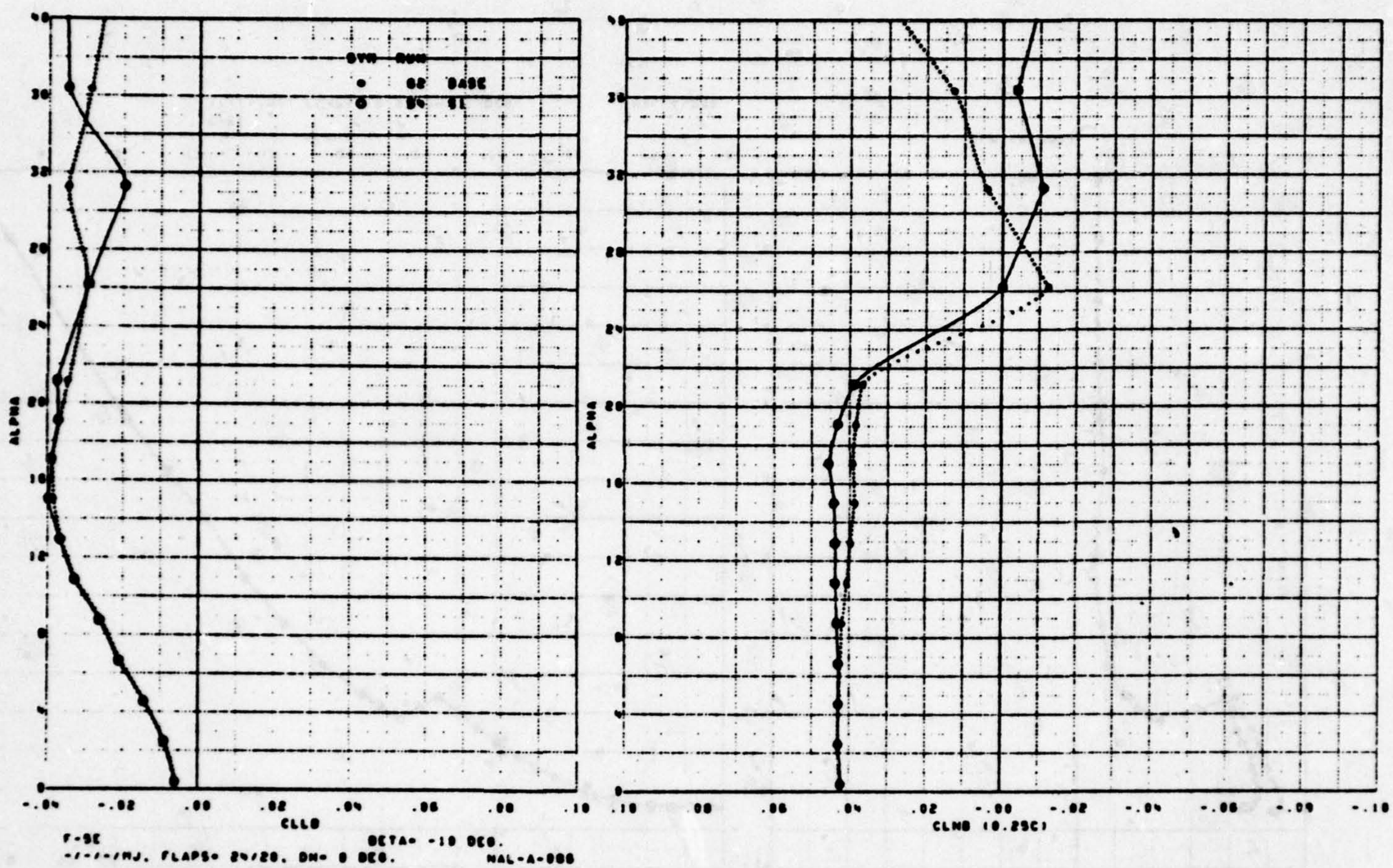


Figure 242. Effect of Nose Strakes, S1

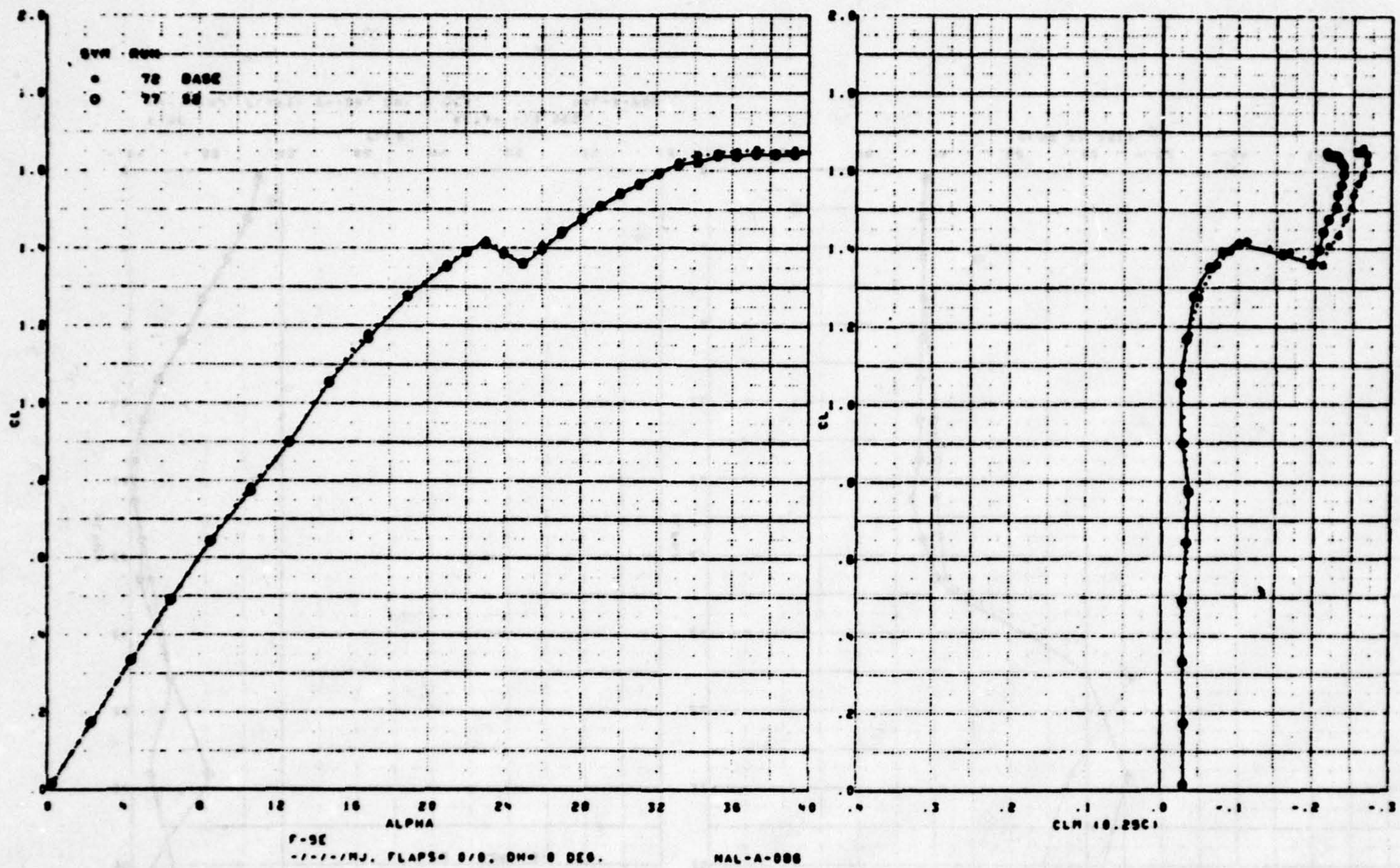


Figure 243. Effect of Nose Strakes, S2

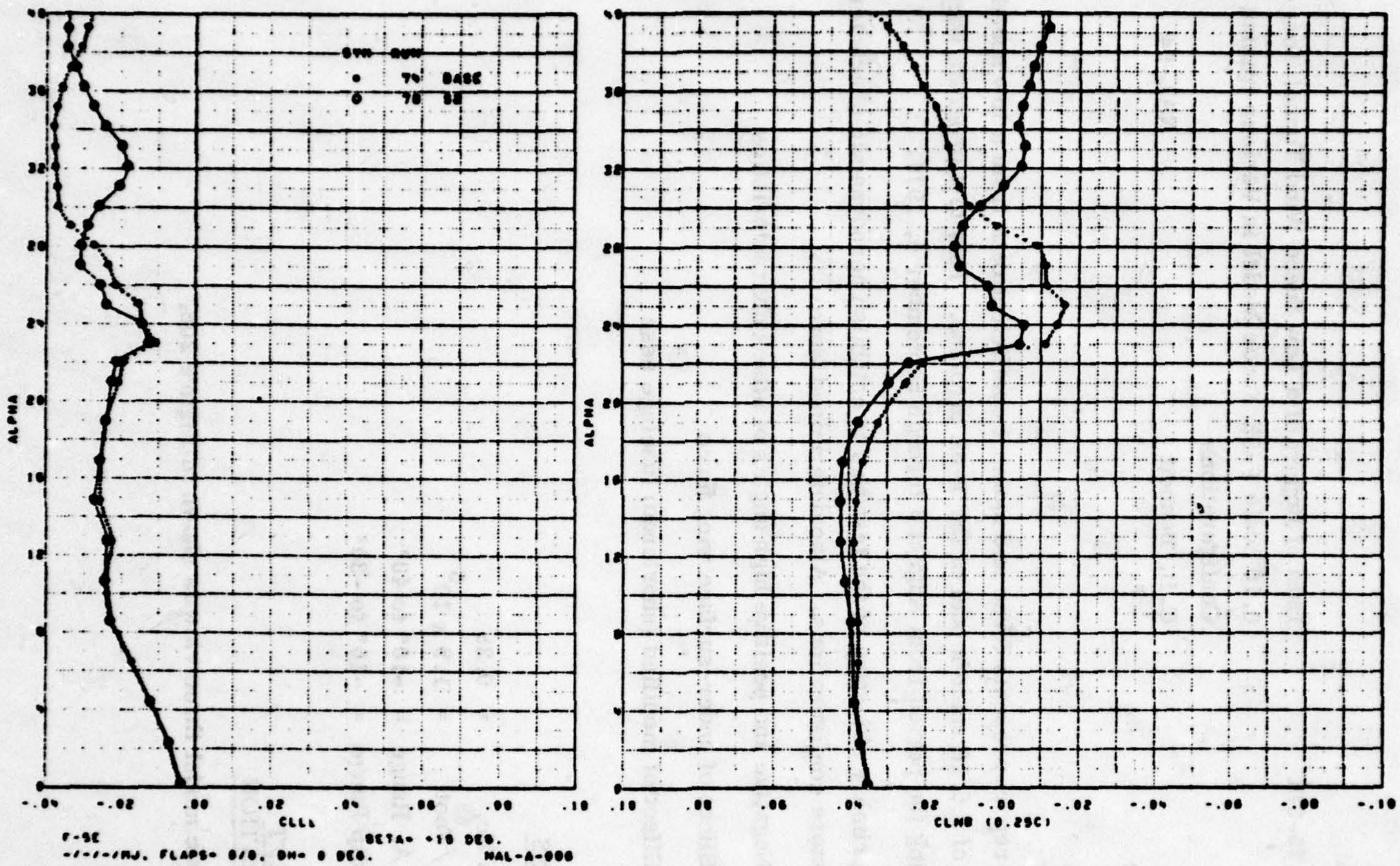


Figure 244. Effect of Nose Strakes, S2

AIRCRAFT **F-5E** REFERENCE **48**

TEST REPORT

NOR 75-311 — Data of Report of a Low Speed Wind Tunnel Test of a 0.10 Scale F-5E Force Model in Various Iranian Store Configurations

C. B. Bennett NAL-94

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 0.10 scale model of the F-5E airplane. This test program was conducted during the period from August 8 through September 4, 1974.

The primary objective of the test was to establish aerodynamic characteristics of Iranian store configurations. Also determined were:

1. Negative and positive high angles of attack characteristics
2. Effect of under-surface wing fence
3. Effect of modified (shortened) fuselage nose

TEST CONDITIONS

Mach No.	=	0.28
R. N./Foot	=	1.9×10^6
A. O. A. Range	=	-10° to 40°
Sideslip Range	=	-10° to -30°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 208.

CONFIGURATION CHANGES

Sketches of basic nose configuration changes applicable to this study are shown in Figure 245.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 246 shows the effect on lateral/directional stability of the blunt nose, B5.

Data effects for objectives 1 and 2 listed above were insufficient for inclusion.

NOSE SHAPE

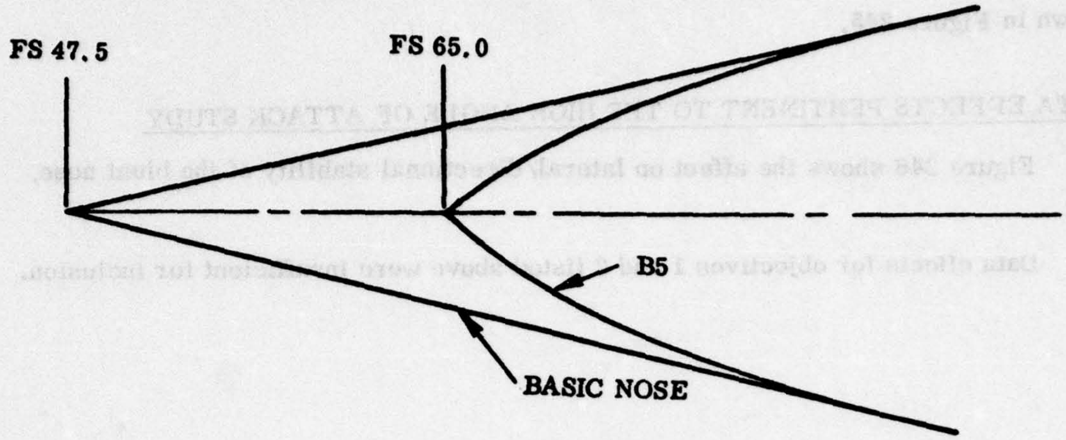


Figure 245. Basic Nose and Blunt Nose B5

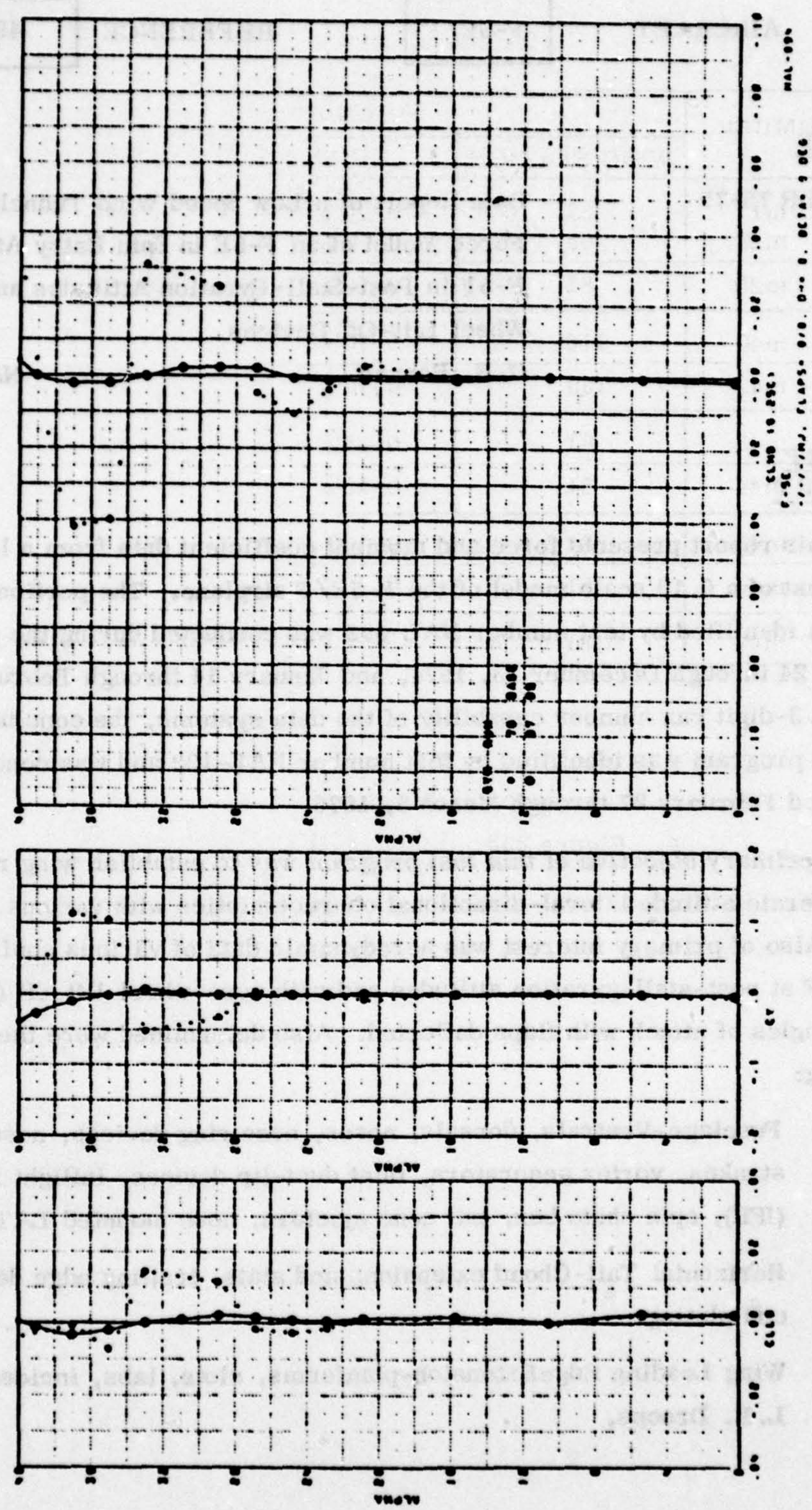


Figure 246. Effect of Nose Bluntness

AIRCRAFT **F-5E/F** REFERENCE **49**

TEST REPORT

NOR 75-79 Data Report of a Low Speed Wind Tunnel Test of a 10% Force Model of an F-5E in Spin Entry Attitudes and F-5F in Post-Stall-Gyration Attitudes and with Nose-Wheel Lift-Off Devices

G. B. Bennett NAL-92, 122

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 0.10 scale model of the F-5E/F airplane. The portion of this test program identified by test number NAL-092 was conducted during the periods October 24 through December 13, 1974, and January 14 through February 10, 1975. Due to a 3-digit run number capability of the data systems, the concluding phase of this test program was identified by test number NAL-122 and was conducted during the period February 27 through March 5, 1975.

A primary objective of this test program was to establish wing rock, spin entry and moderate attitude lateral-directional characteristics with various F-5E configurations. Also of primary interest was aerodynamic data of various configurations of the F-5F at post-stall-gyration attitudes and with nose-wheel-lift-off (NWLO) devices at low angles of attack with flaps deflected. Also determined were the effects of the following:

1. Fuselage-Ventrals, dorsals, noses, nose ring devices, nose gear doors, strakes, vortex generators, inlet duct-lip devices, inflight refueling probe (IFR), spin chute box, tail cone ejectors, nose mounted LATARS.
2. Horizontal Tail-Chord extensions and slats, trailing edge devices, camber, end plating.
3. Wing Leading Edge Extension-planforms, slots, tabs, incidence angle, L. E. Droops.

4. Vertical Tail-Planforms, Fences, leading and trailing edge extensions, plating, tail lengths.
5. Stores-Fins, nose strakes, Pylon modifications.
6. Wing-Fences, vortex generators, trip strips, sawtooths, leading edge extensions, incidence angle, control and lift devices
7. Model Build-ups

TEST CONDITIONS

Mach No. = 0.26

R. N./Foot = 1.5×10^6

A. O. A. Range = -10° to 40°

Sideslip Range = 10° to -30°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figures 208 and 222.

CONFIGURATION CHANGES

Sketches of configuration changes applicable to this study are shown in the following figures:

Figure 244 Leading edge sawtooth

Figures 248 Leading edge snag

Figures 253 & 254 Wing Fence

Figures 261 & 262 LEX's

Figures 263 LEX fillet

Figure 266 Dorsal

Figures 267 & 268 Vertical tails

Figure 271 Nose vortex generators

Figure 274 Nose strakes

Figure 277 Leading edge flaps

Figure 279 Twin ventrals

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figures 249 and 250 show the effect on longitudinal characteristics and lateral/directional stability of the leading edge sawtooth, W20, W21, W23 and W27. Figures 251 and 252 show similar data for the leading edge snag, m65, m69, m70, m71 and m72.

Figures 255 and 256 show the effect on longitudinal characterics and lateral/directional stability of wing fences m43, m44 and m45. Similar plots are shown in Figures 257, 258, 259 and 260 for wing fences, m28, m29, m40 and m42 and wing fences m46 and m47.

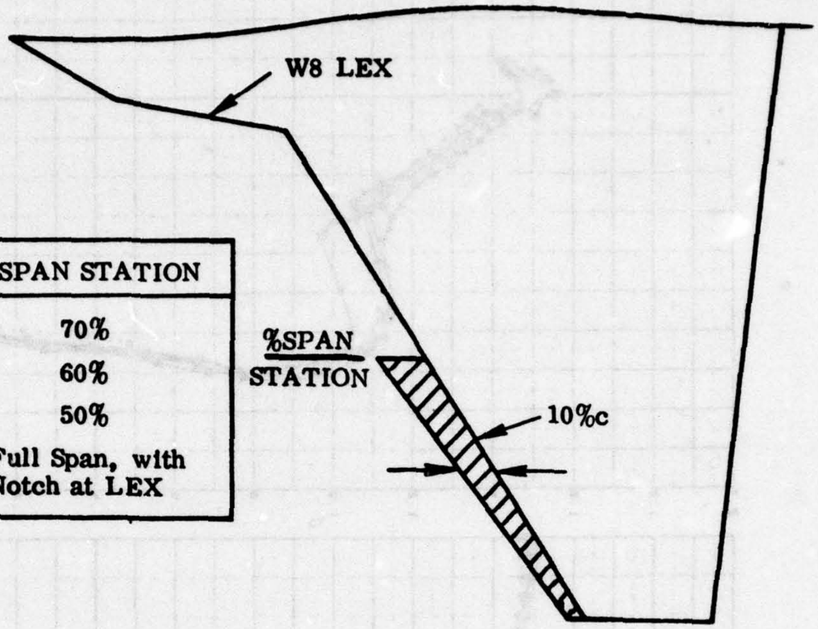
Figure 264 shows the effect on C_{LMAX} of LEX planform W8, W22, W24 and W26. Figure 263 shows the effect on longitudinal characteristics of LEX planforms W8, W18 and W19.

The effect of verticals V1, V3 and V1, V4 and V8 on lateral/directional stability is shown in Figures 269 and 270.

Longitudinal and lateral/directional stability effects of nose vortex generators m5, m59, m63 and m67 are shown in Figures 272 and 273. Similar plots for nose strakes S3, S4, S5 and S6 are shown in Figures 275 and 276.

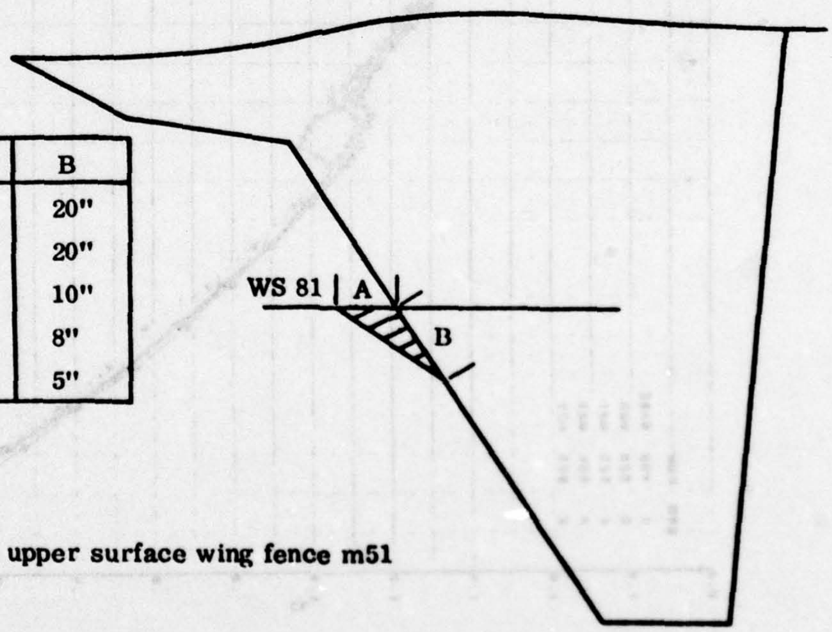
Lateral/directional stability effects of closing the leading edge flap gap are shown in Figure 278. A similar effect of twin ventrals, F11, is shown in Figure 280.

Data effects for objective 2 listed above (horizontal tail configuration changes) were not considered pertinent.



WING	% SPAN STATION
W20	70%
W21	60%
W23	50%
W27	Full Span, with Notch at LEX

Figure 247. Leading Edge Sawtooth



SNAG	A	B
m65*	10%c	20"
m69*	5%c	20"
m70*	10%c	10"
m71*	7-5%c	8"
m72*	10%c	5"

*All tests run with upper surface wing fence m51

Figure 248. Snag at WS 81

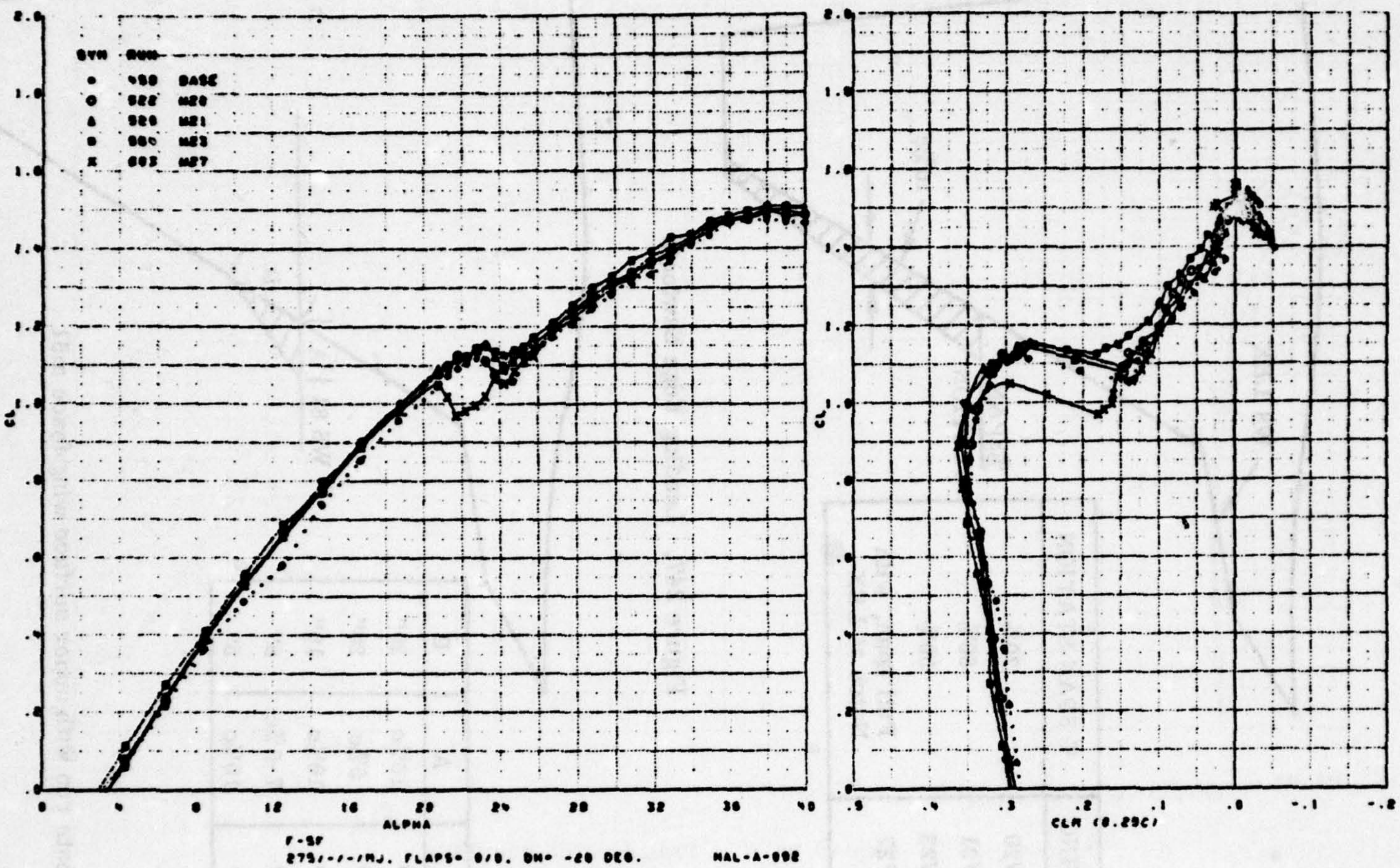


Figure 249. Effect of Leading Edge Sawtooth

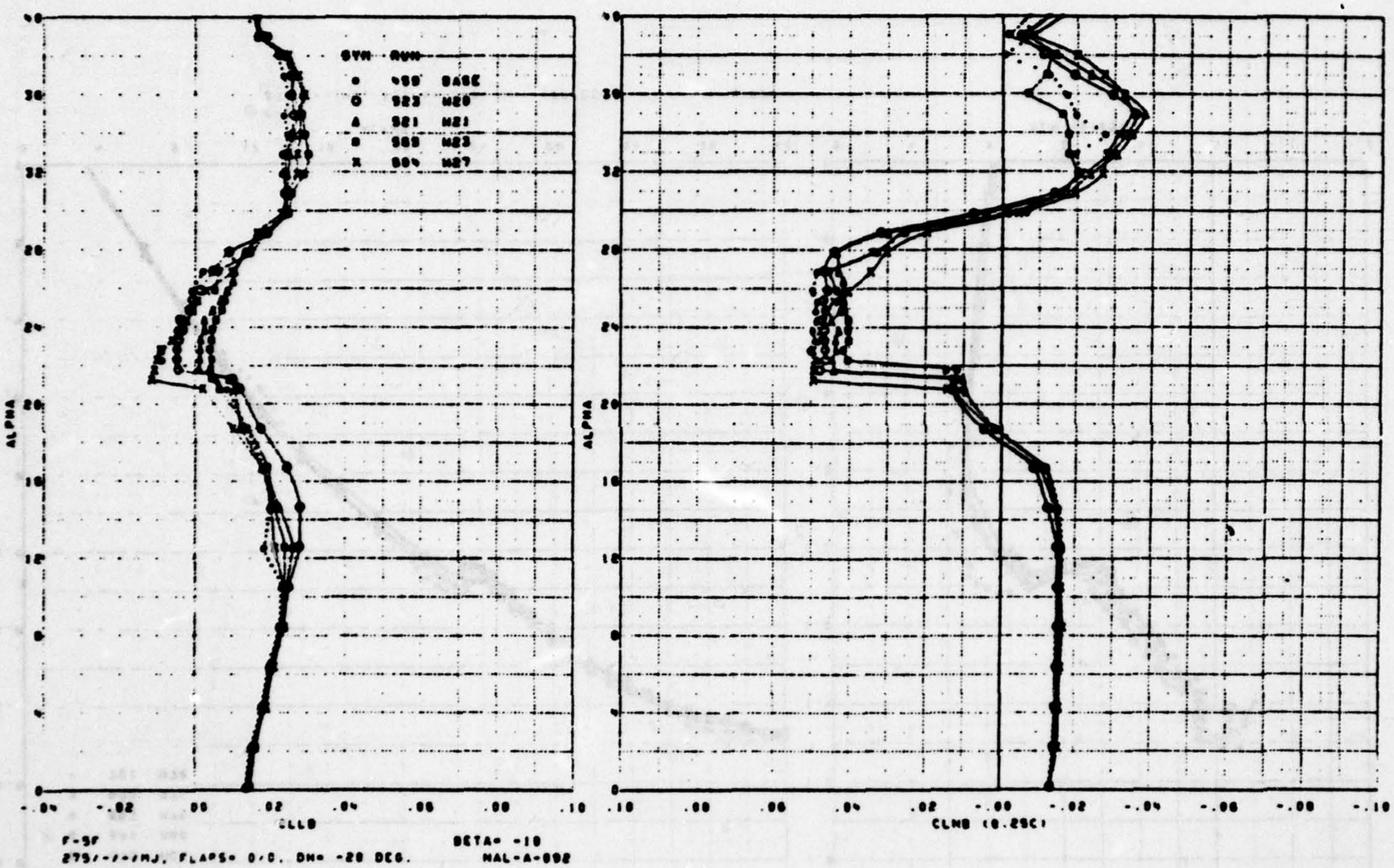


Figure 250. Effect of Leading Edge Sawtooth

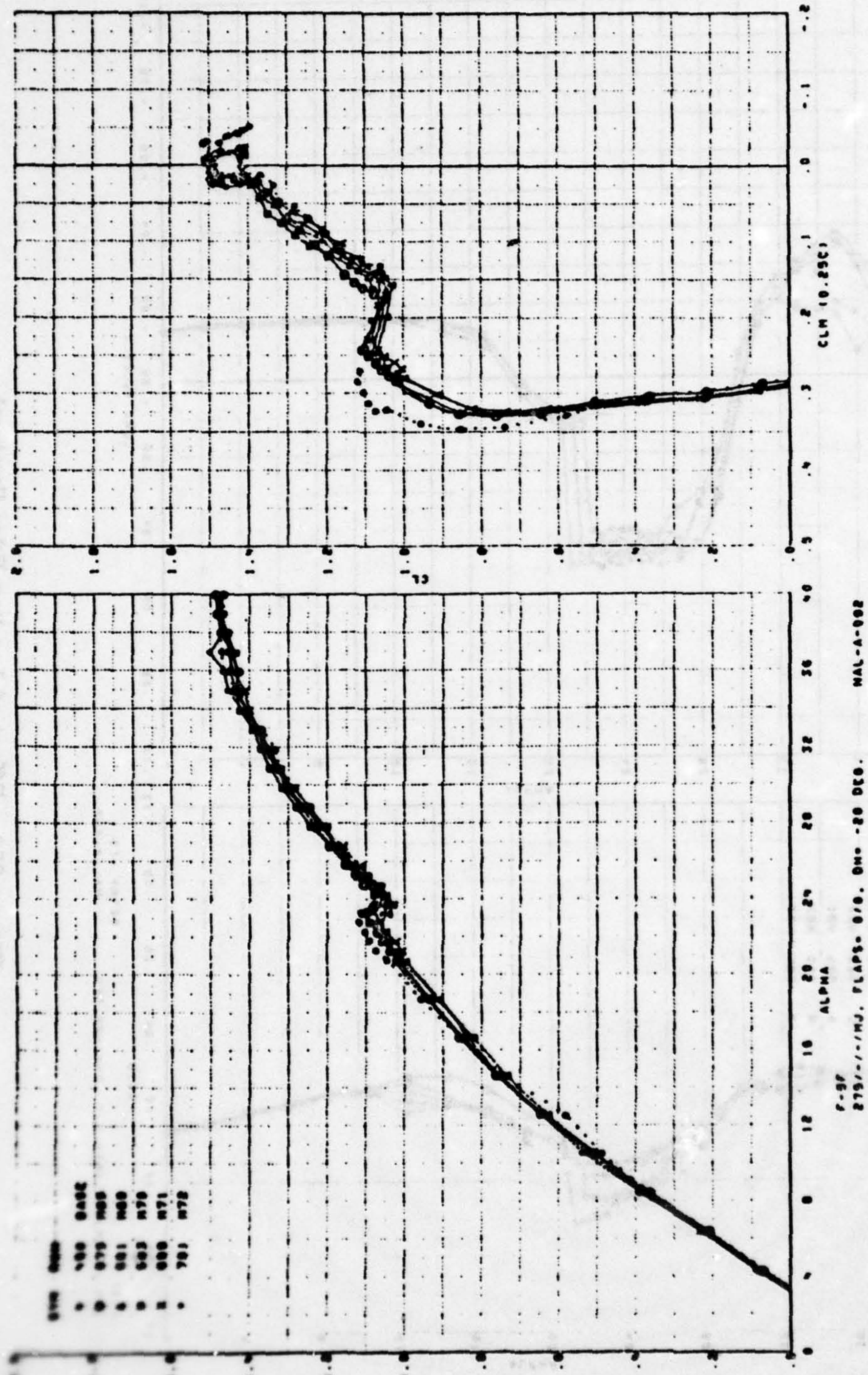


Figure 251. Effect of Snag

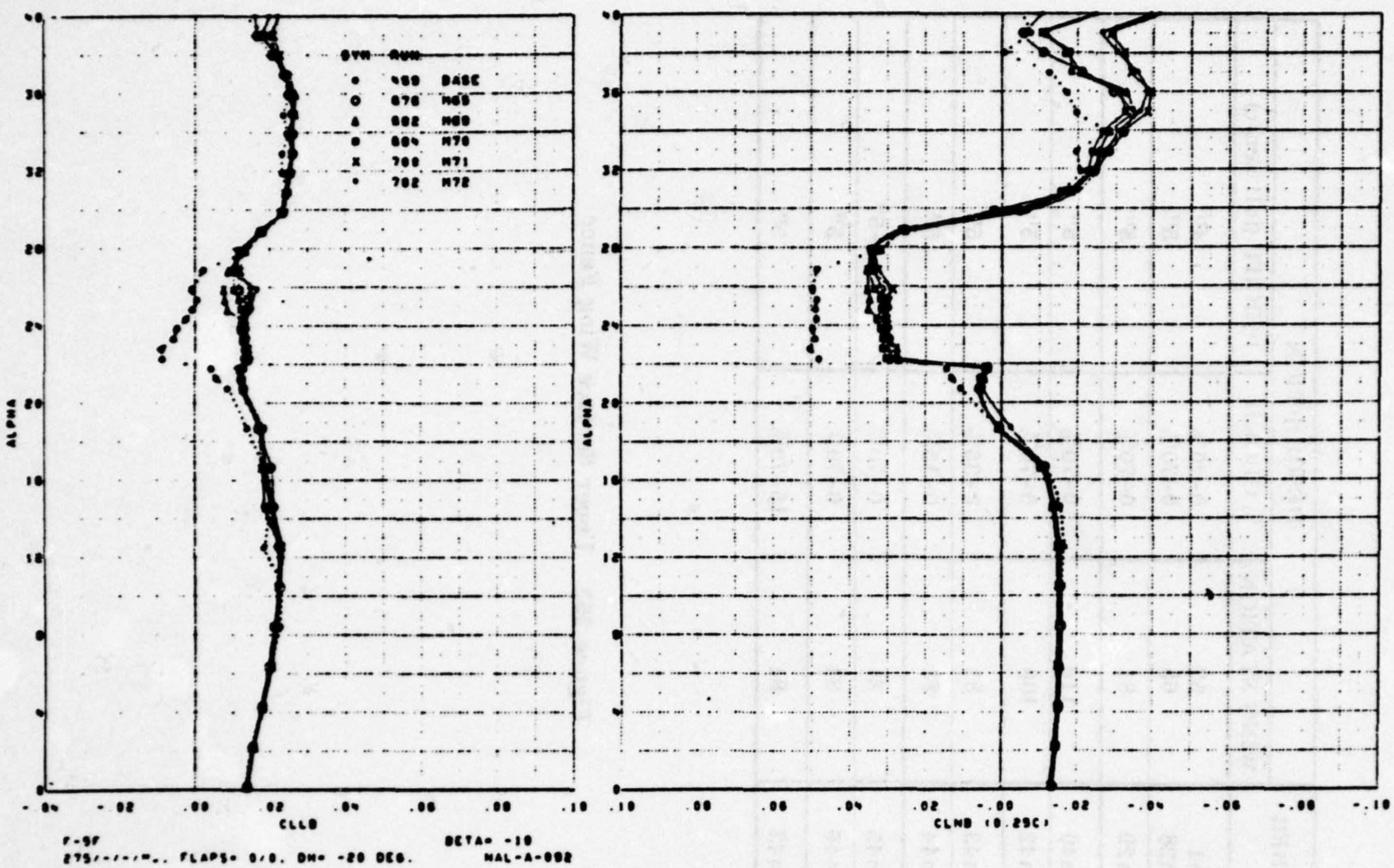


Figure 252. Effect of Snag

NUMBER	DESCRIPTION		
	WING STATION	% CHORD	HEIGHT (full scale)
m1	57	0-20%	4"
m28	65	0-70%	5"
m29	81	0-70%	5"
m40	116	0-70%	5"
m42	100	0-70%	5"
m43	81	0-35%	5"
m44	81	0-15%	5"
m45	81	0-70%	2-5"
m46	81	0-70%	5"
m47	81	15-70%	5"

Figure 253. Upper Surface Wing Fence

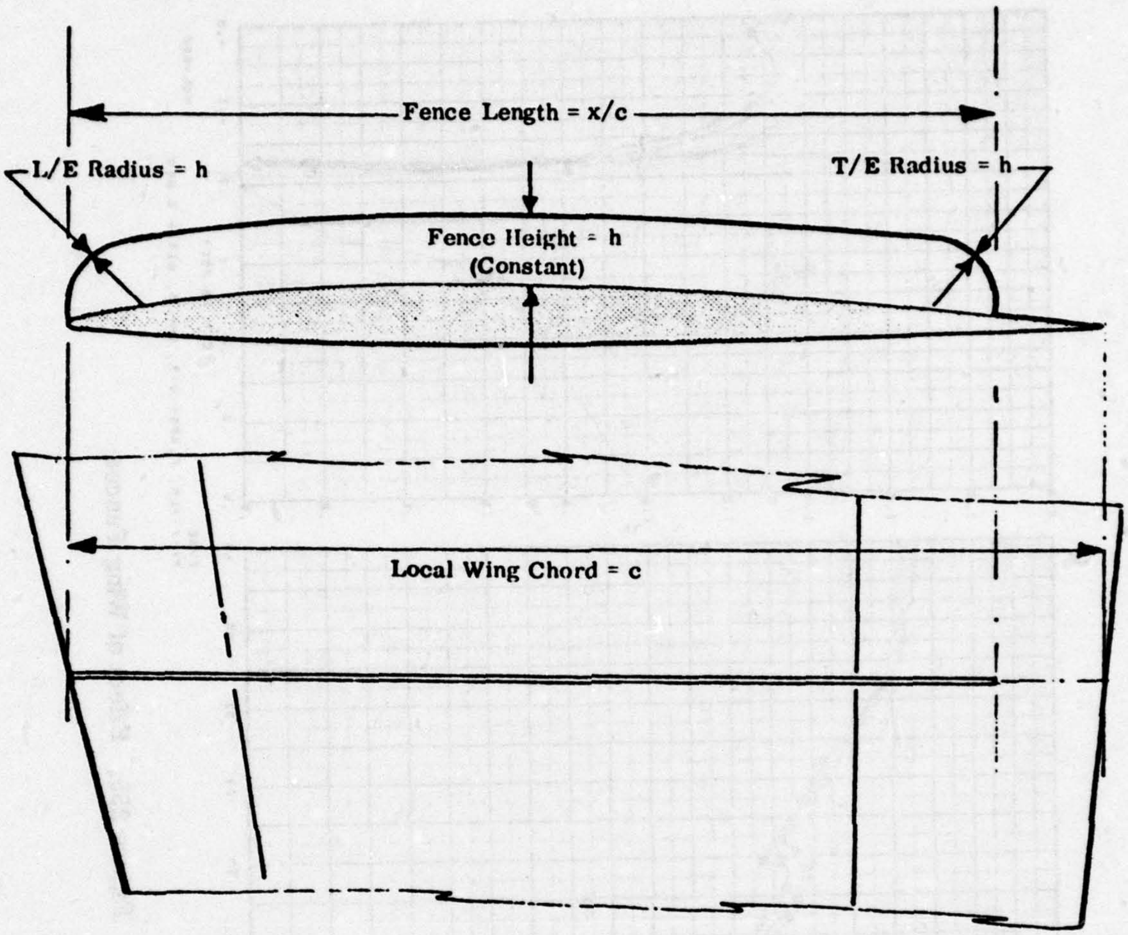


Figure 254. F-5E/F Wing Fence Geometry

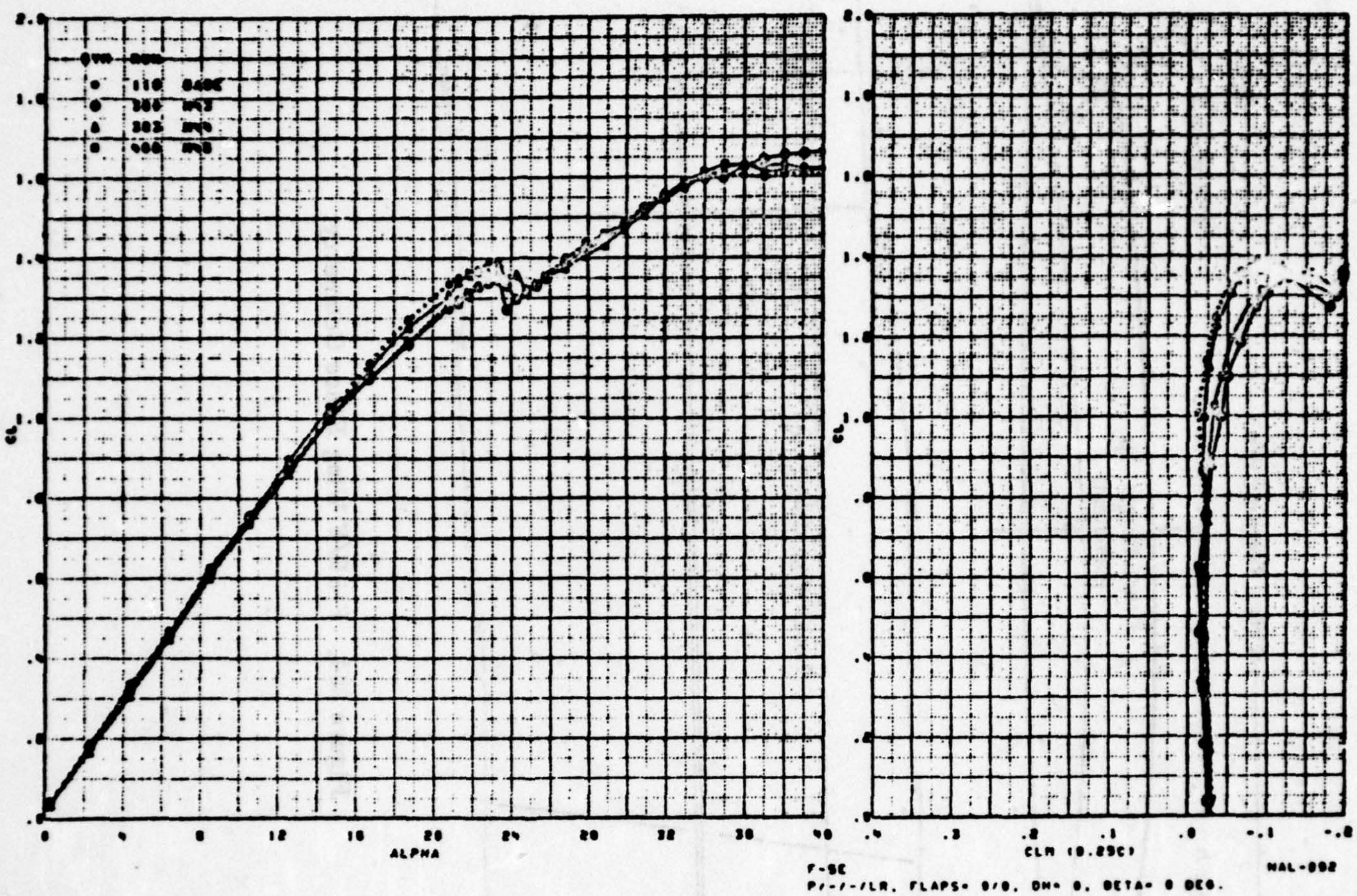


Figure 255. Effect of Wing Fences

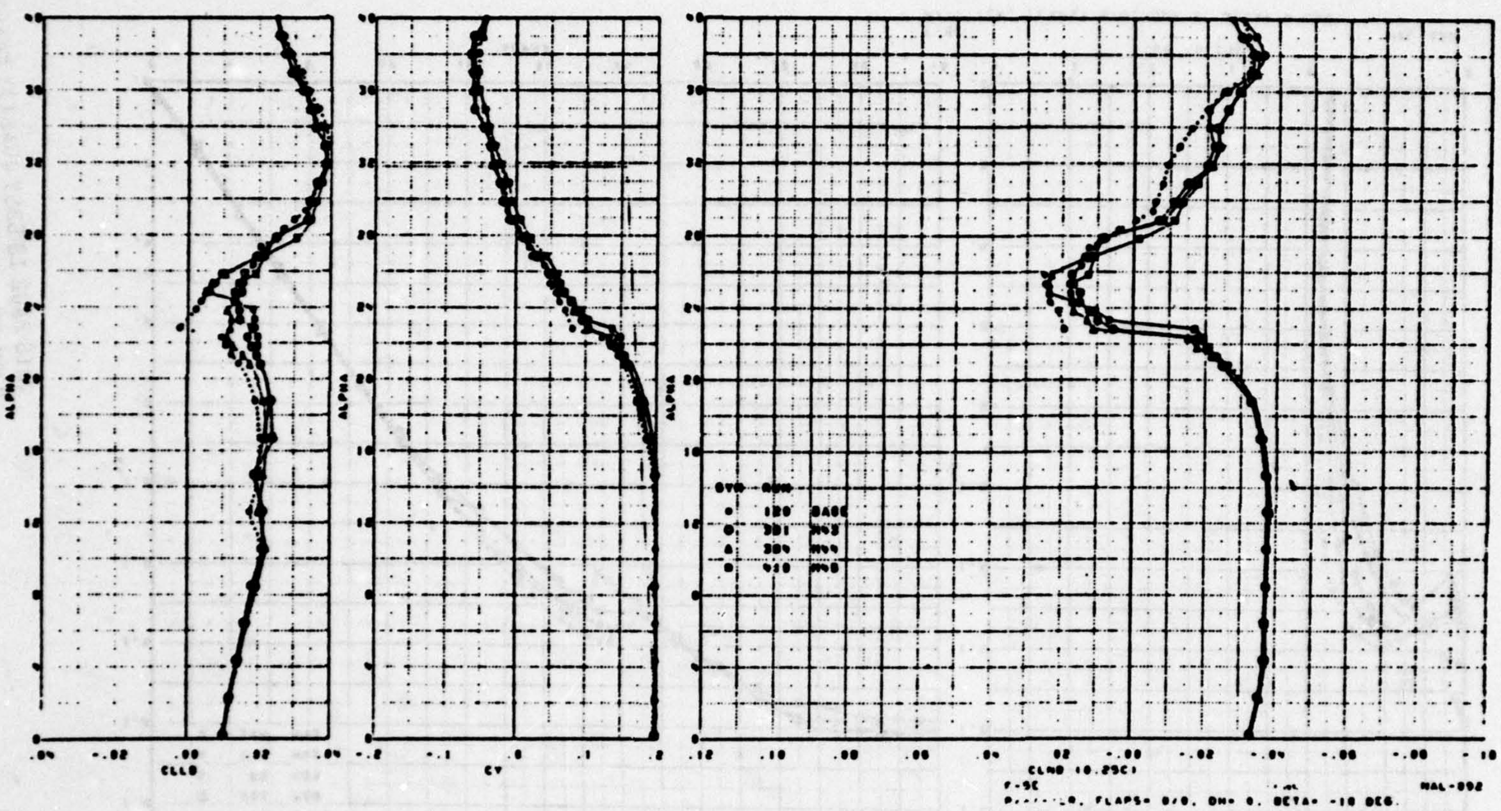


Figure 256. Effect of Wing Fences

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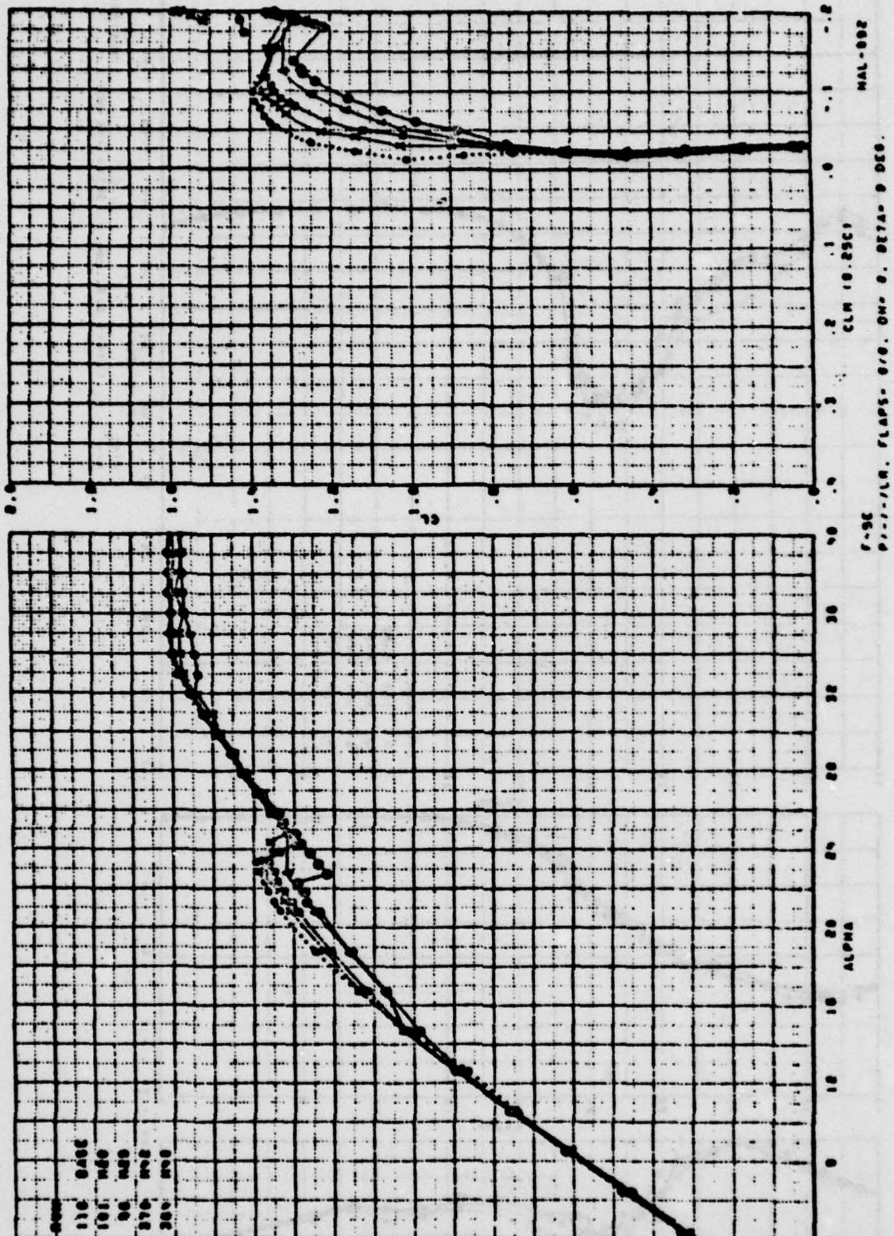


Figure 257. Effect of Wing Fences

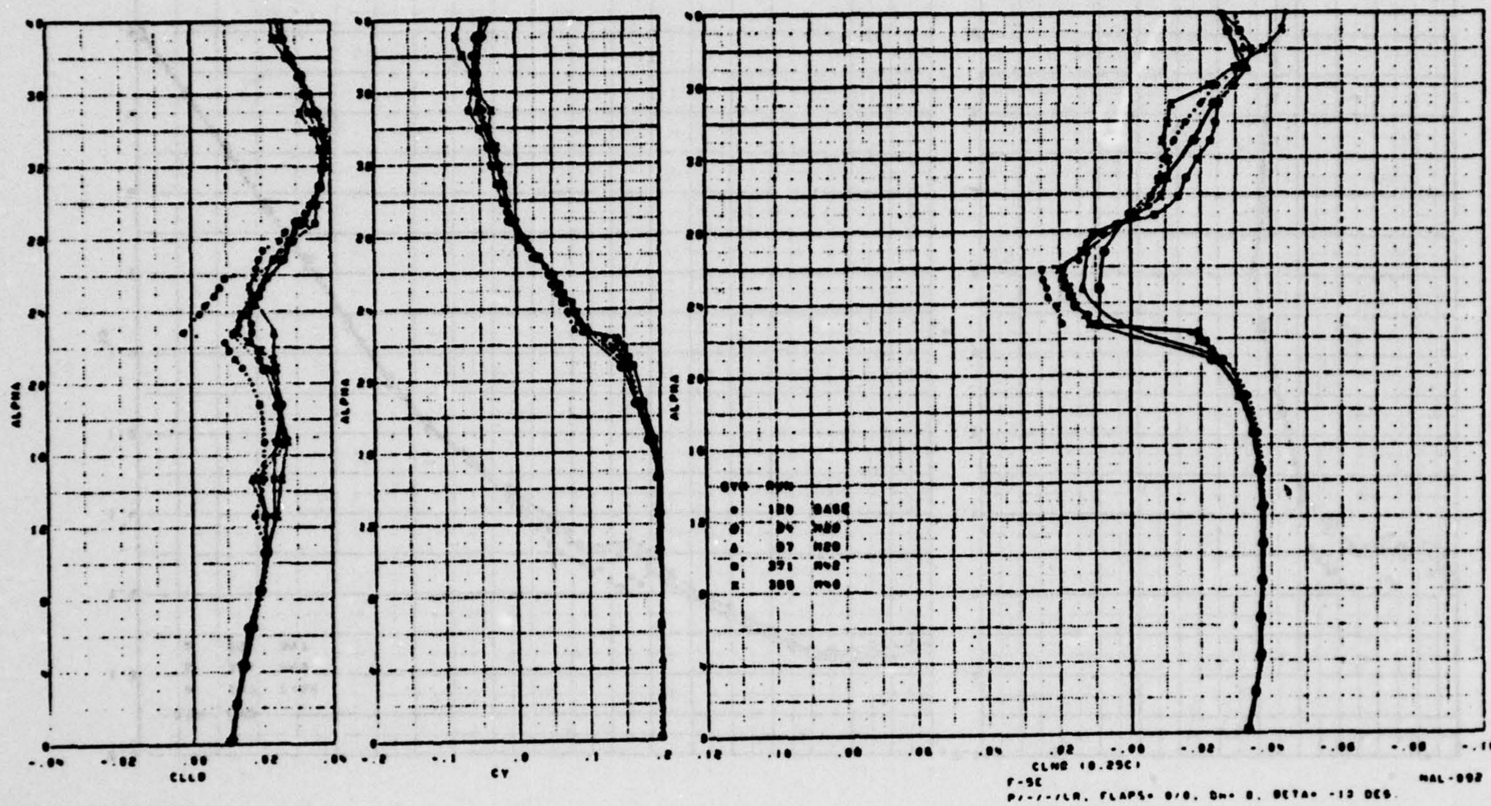


Figure 258. Effect of Wing Fences

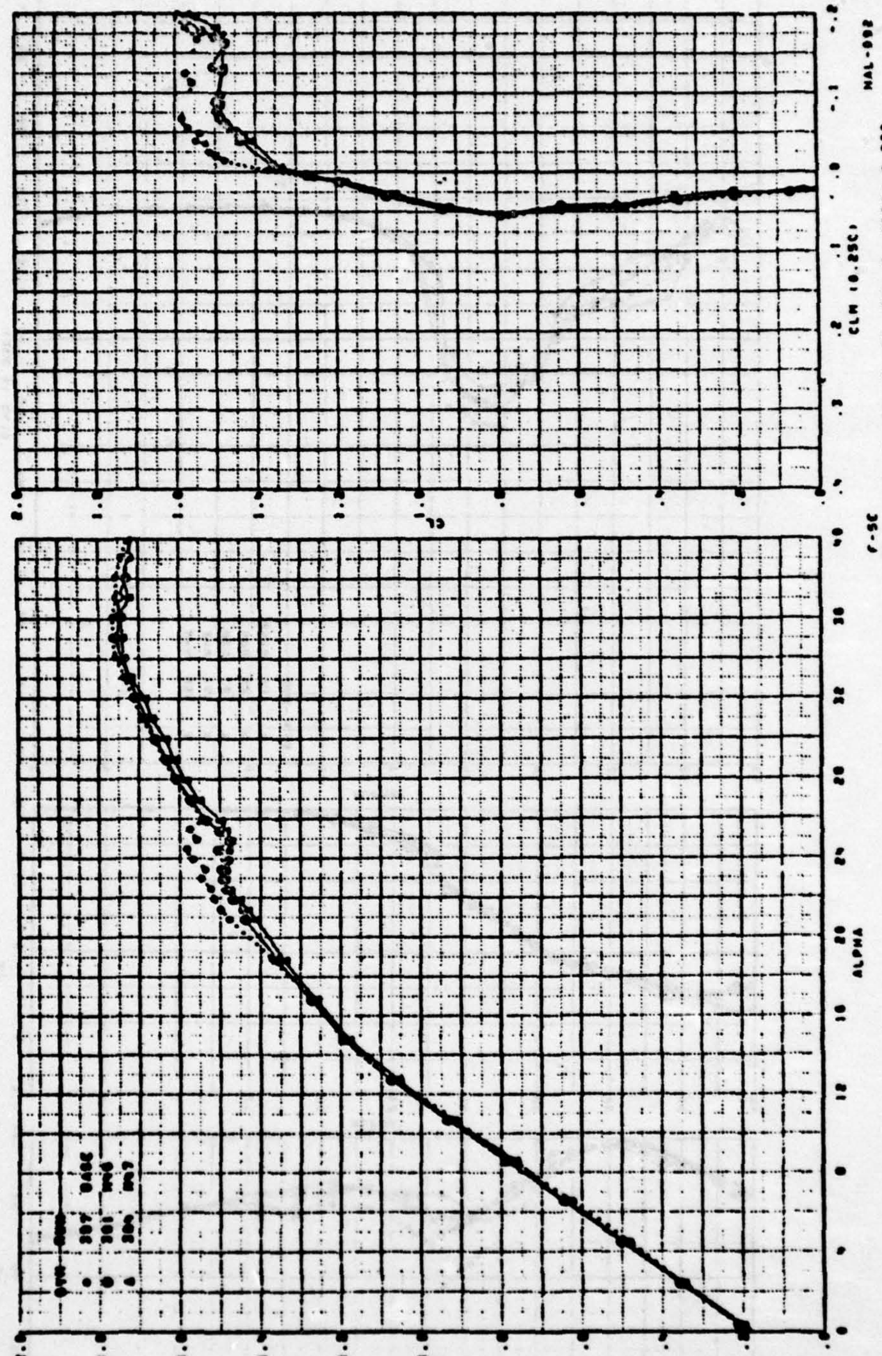


Figure 259. Effect of Wing Fences

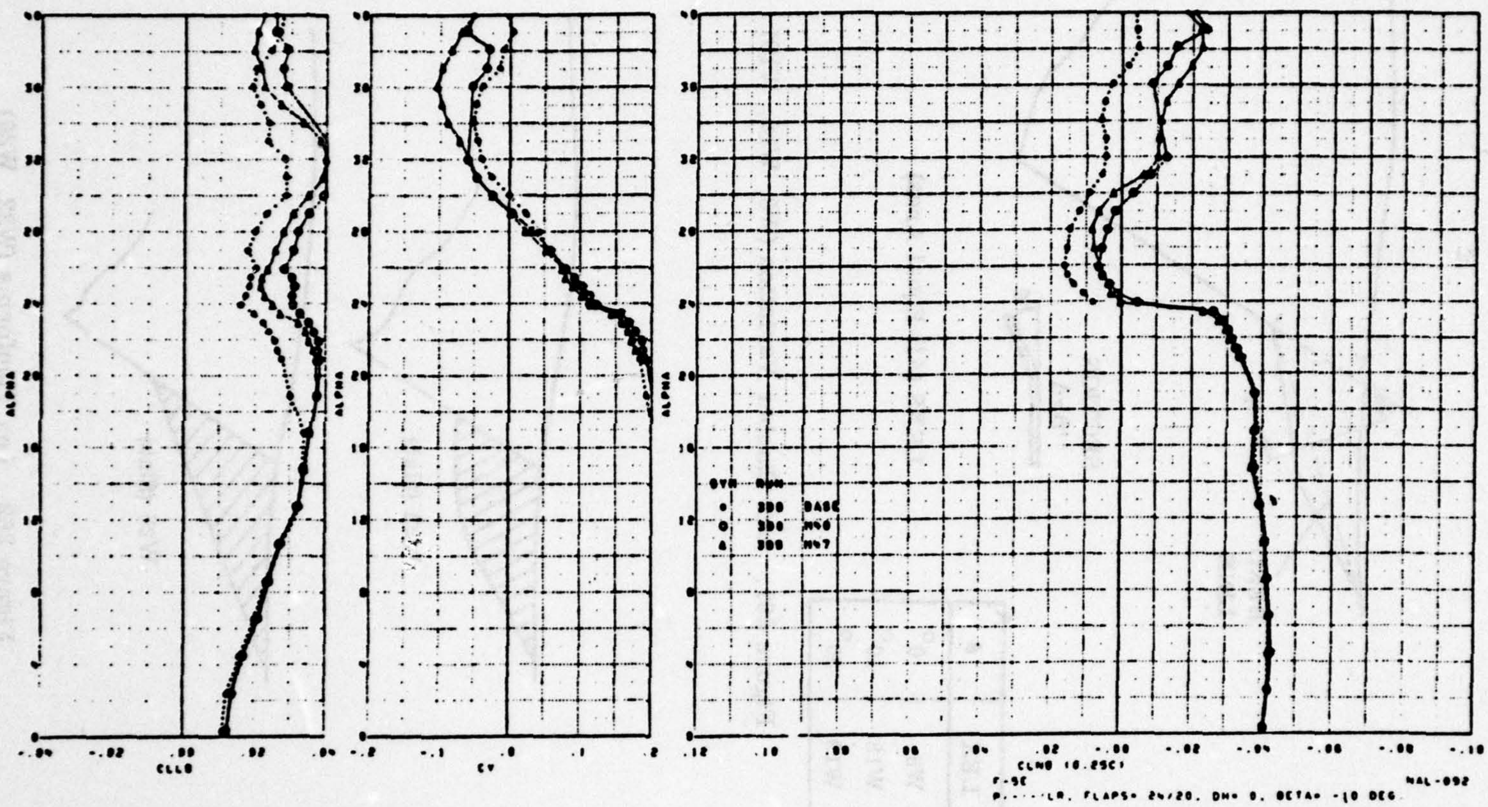
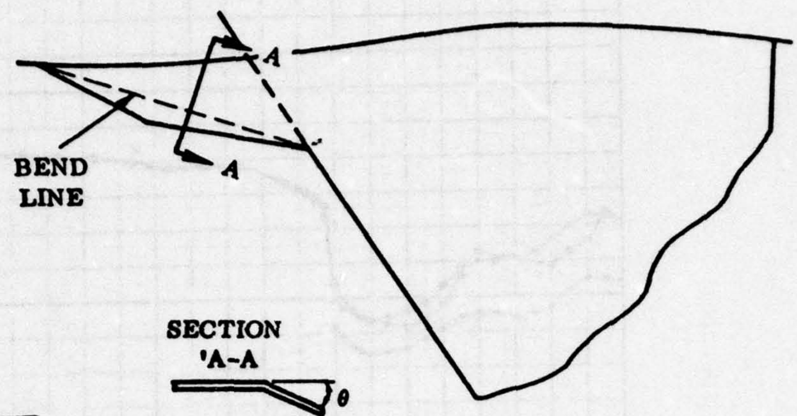


Figure 260. Effect of Wing Fences



LEX	θ
W8	0°
W18	10°
W19	20°

Figure 261. Lex Camber Variation (W8, W18, W19)

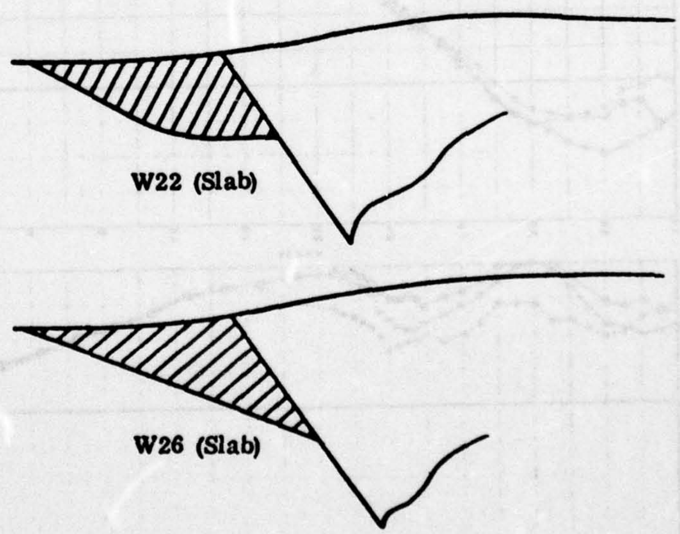


Figure 262. Lex Planforms (W22, W26)

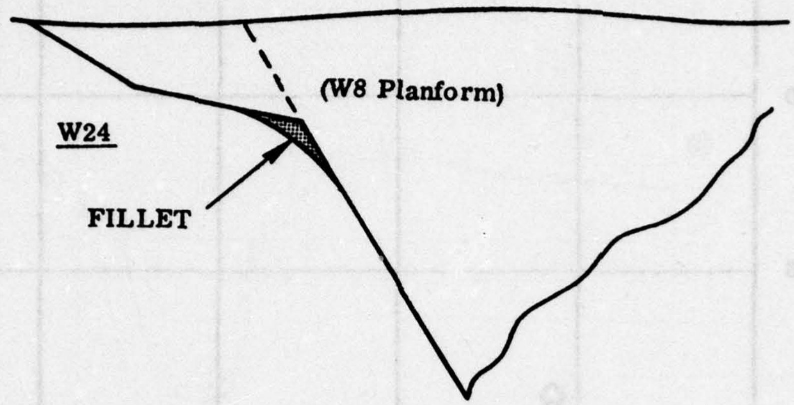


Figure 263. Lex Fillet (W24)

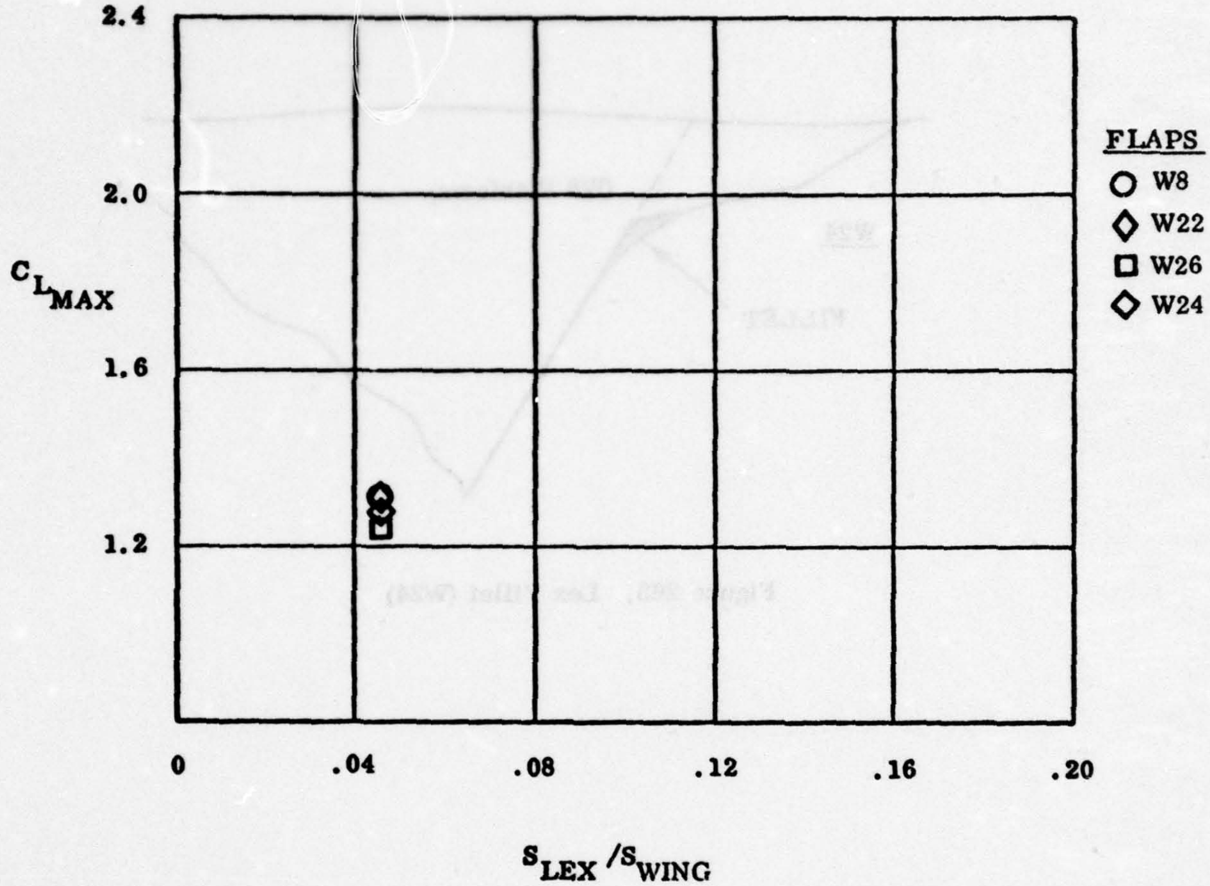


Figure 264. Effect of Lex Planform

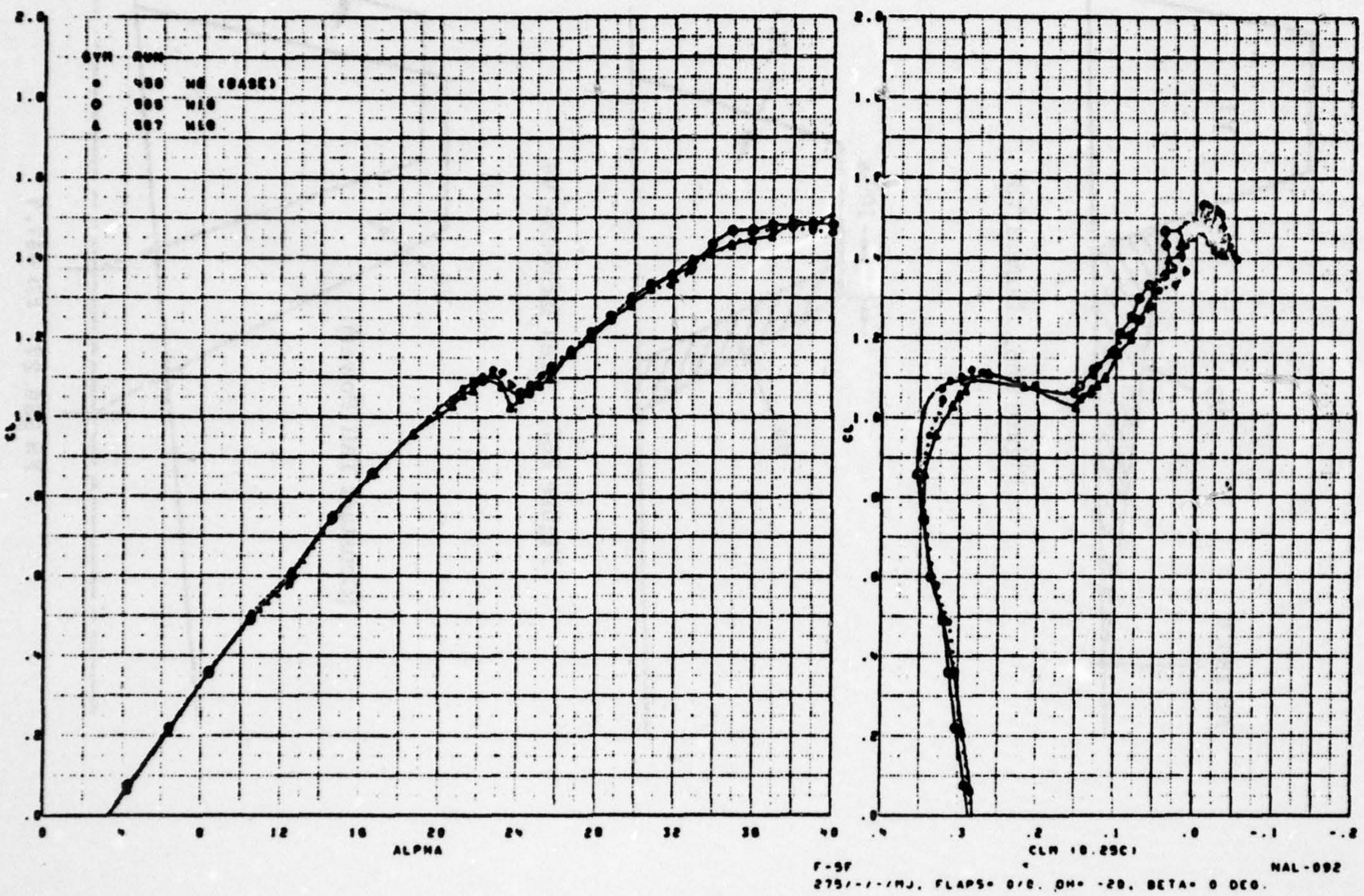


Figure 265. Effect of Lex Camber

AD-A069 647 NORTHROP CORP HAWTHORNE CA AIRCRAFT GROUP F/G 20/4
ANALYSIS OF WIND TUNNEL DATA PERTAINING TO HIGH ANGLE OF ATTACK--ETC(U)
JUL 78 J W HEADLEY F33615-77-C-3062
UNCLASSIFIED NOR-78-69-VOL-2 AFFDL-TR-78-94-VOL-2 NL

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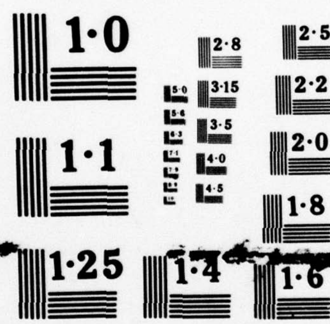


NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

VERTICAL TAILS

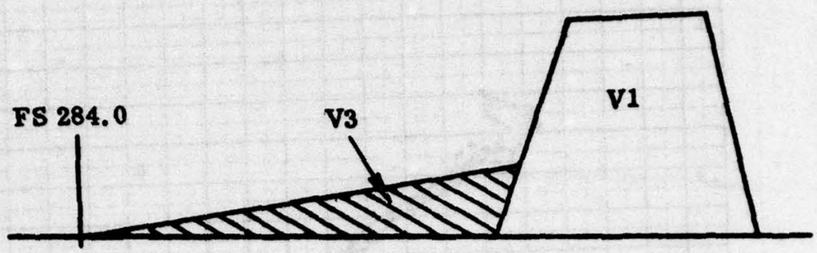


Figure 266. Dorsal V3

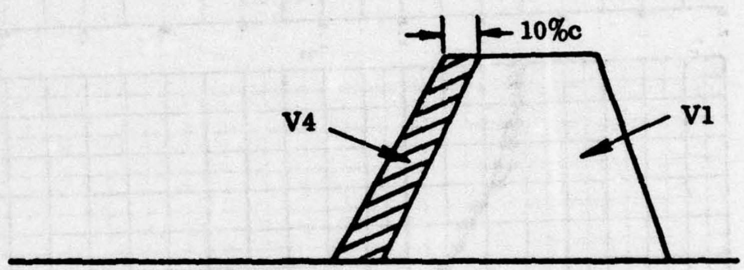


Figure 267. Area Increase V4

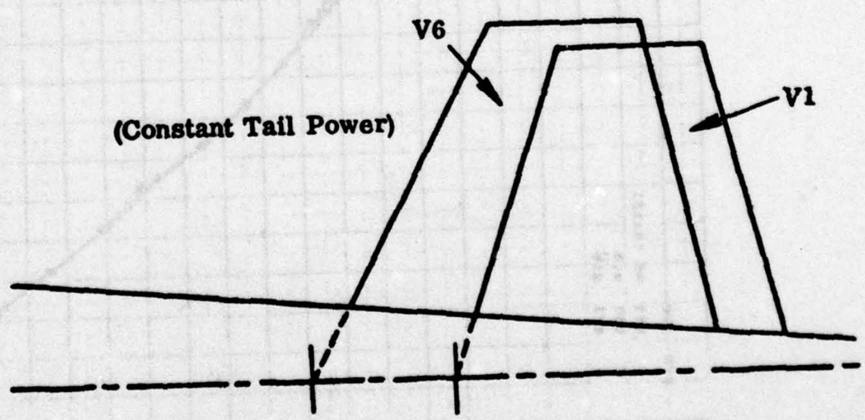


Figure 268. Vertical Tail Location

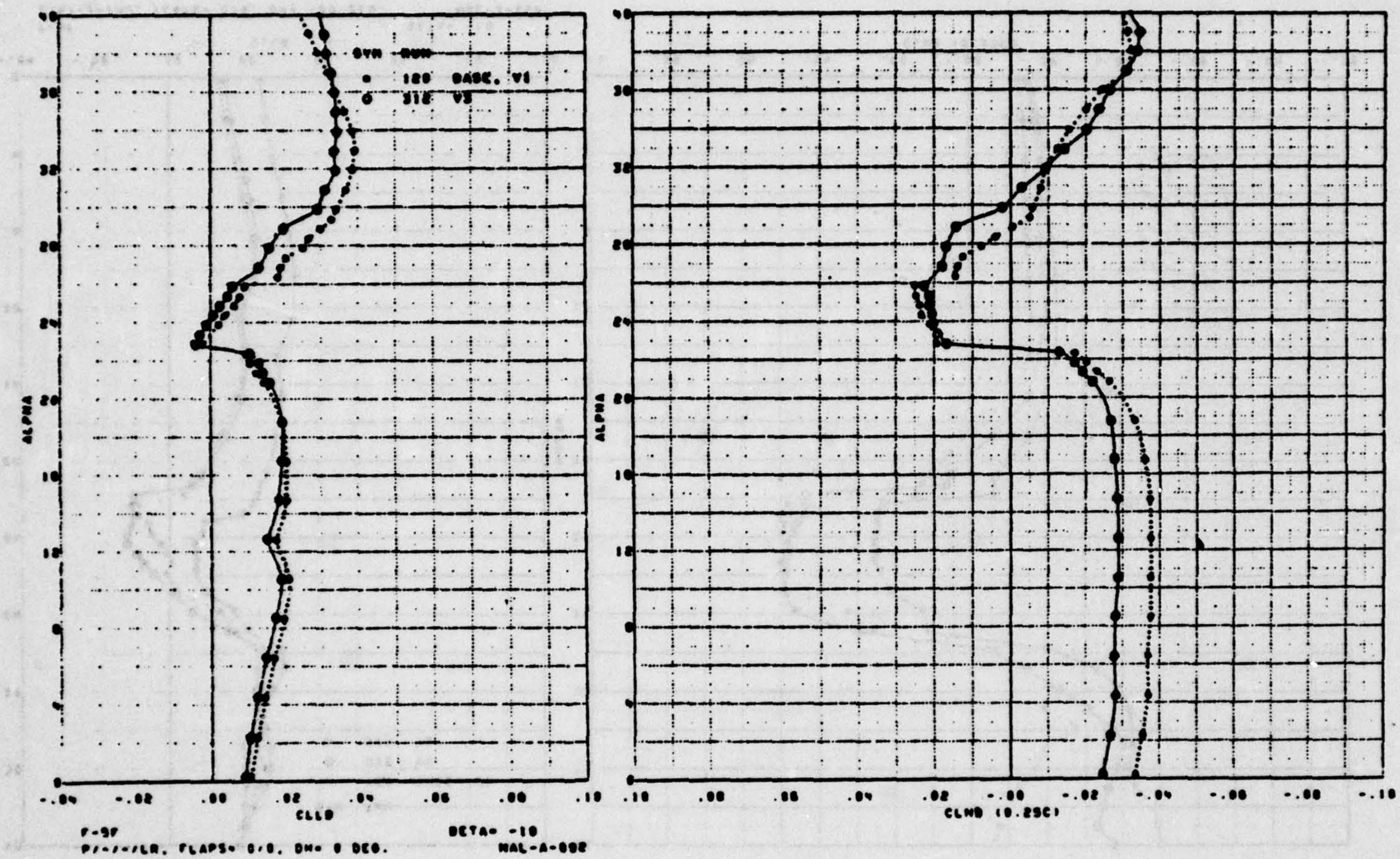


Figure 269. Effect of Increasing Vertical (V1, V3)

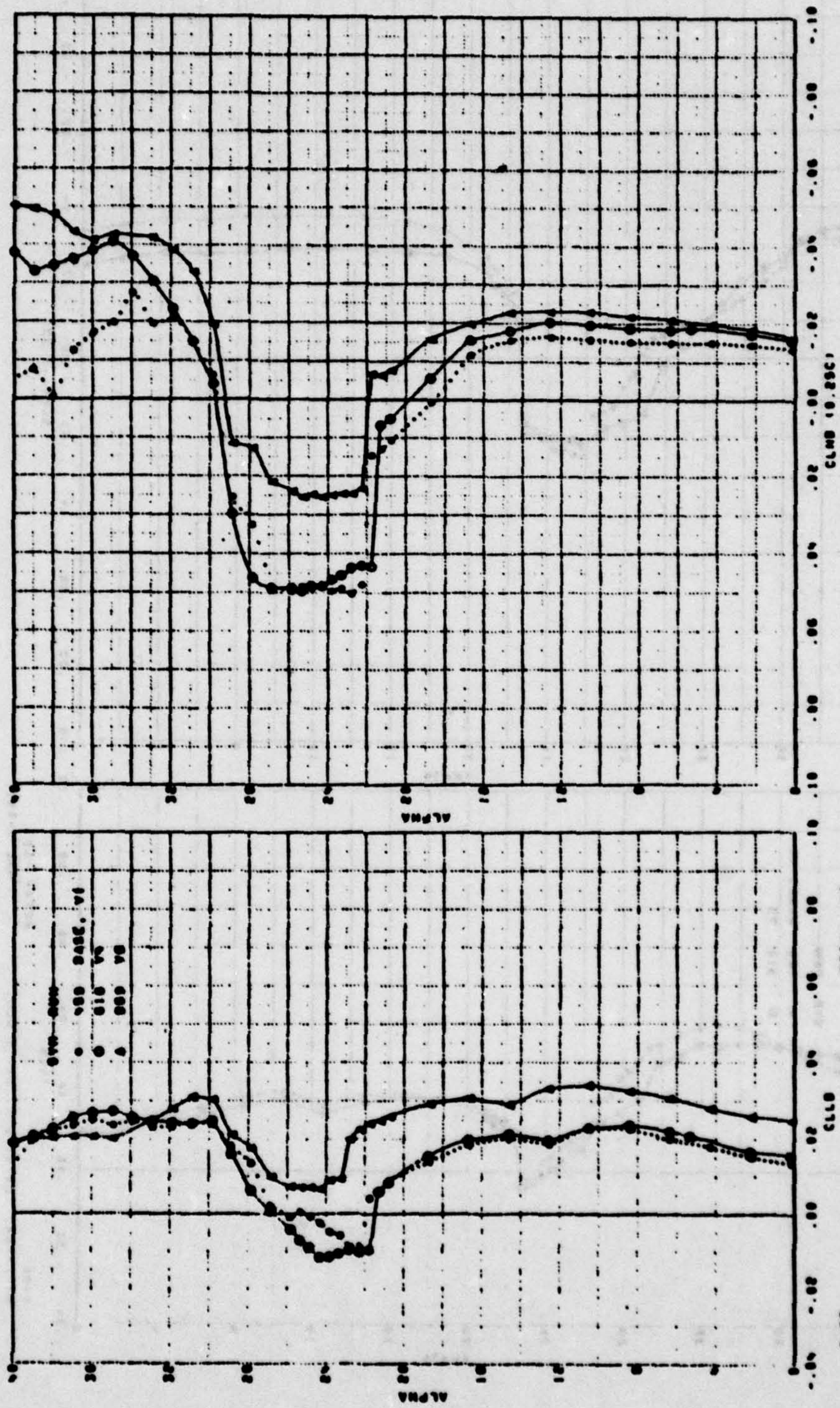
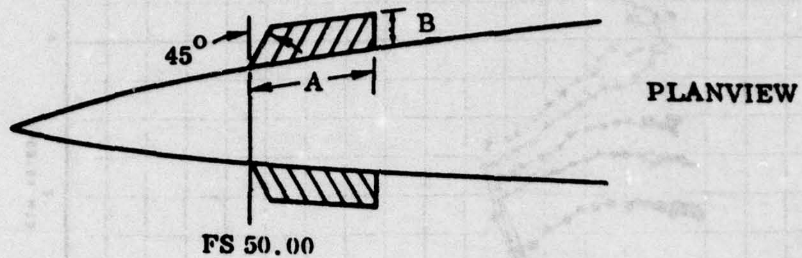


Figure 270. Effect of Increasing Vertical (V1, V4, V8)



GENERATOR	A	B
m5	42.5	6.5
m63	42.5	3.0
m67	42.5	1.5
m59	10.00	2.5

Figure 271. Nose Vortex Generator Planform Shapes

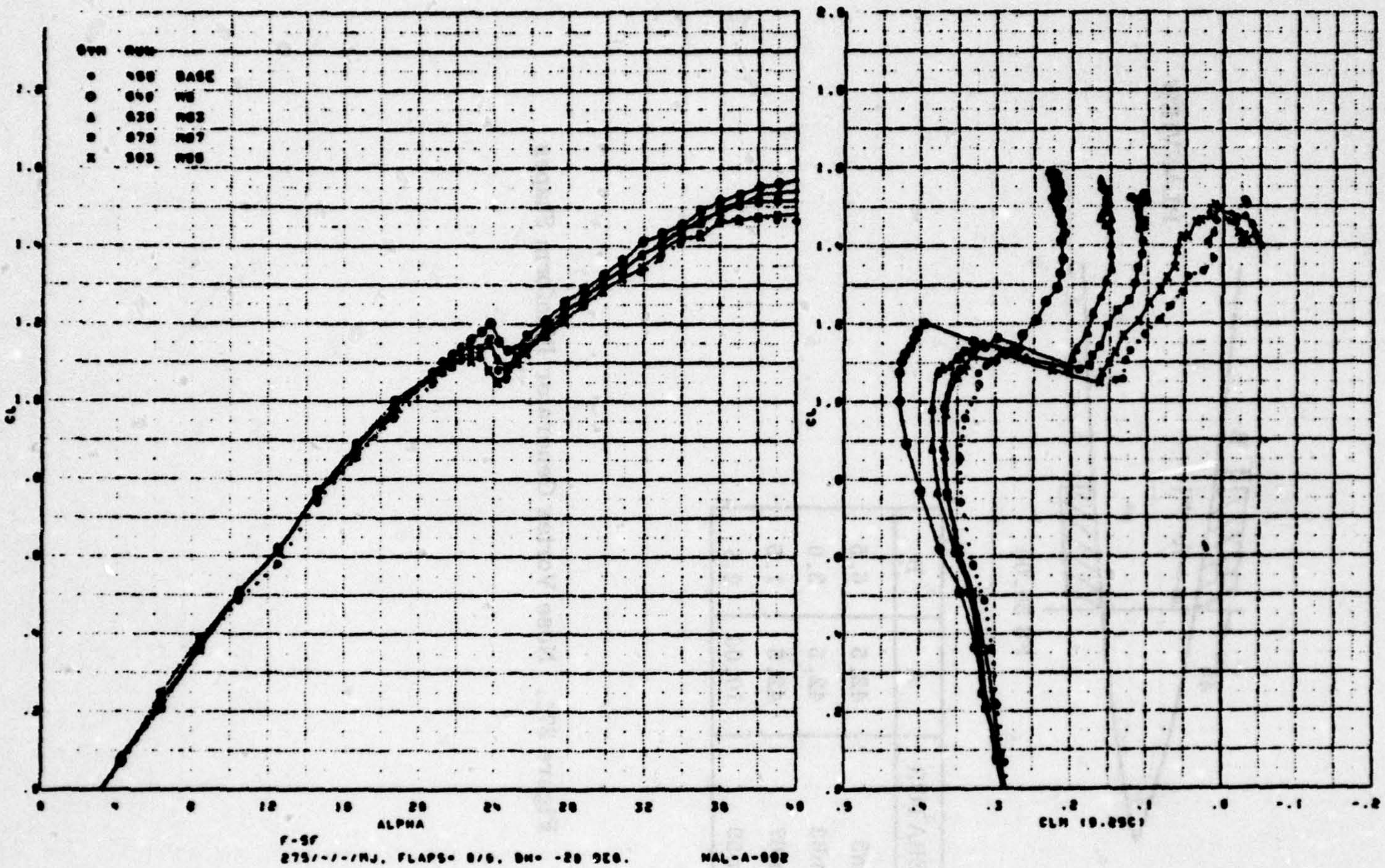


Figure 272. Effect of Nose Vortex Generators

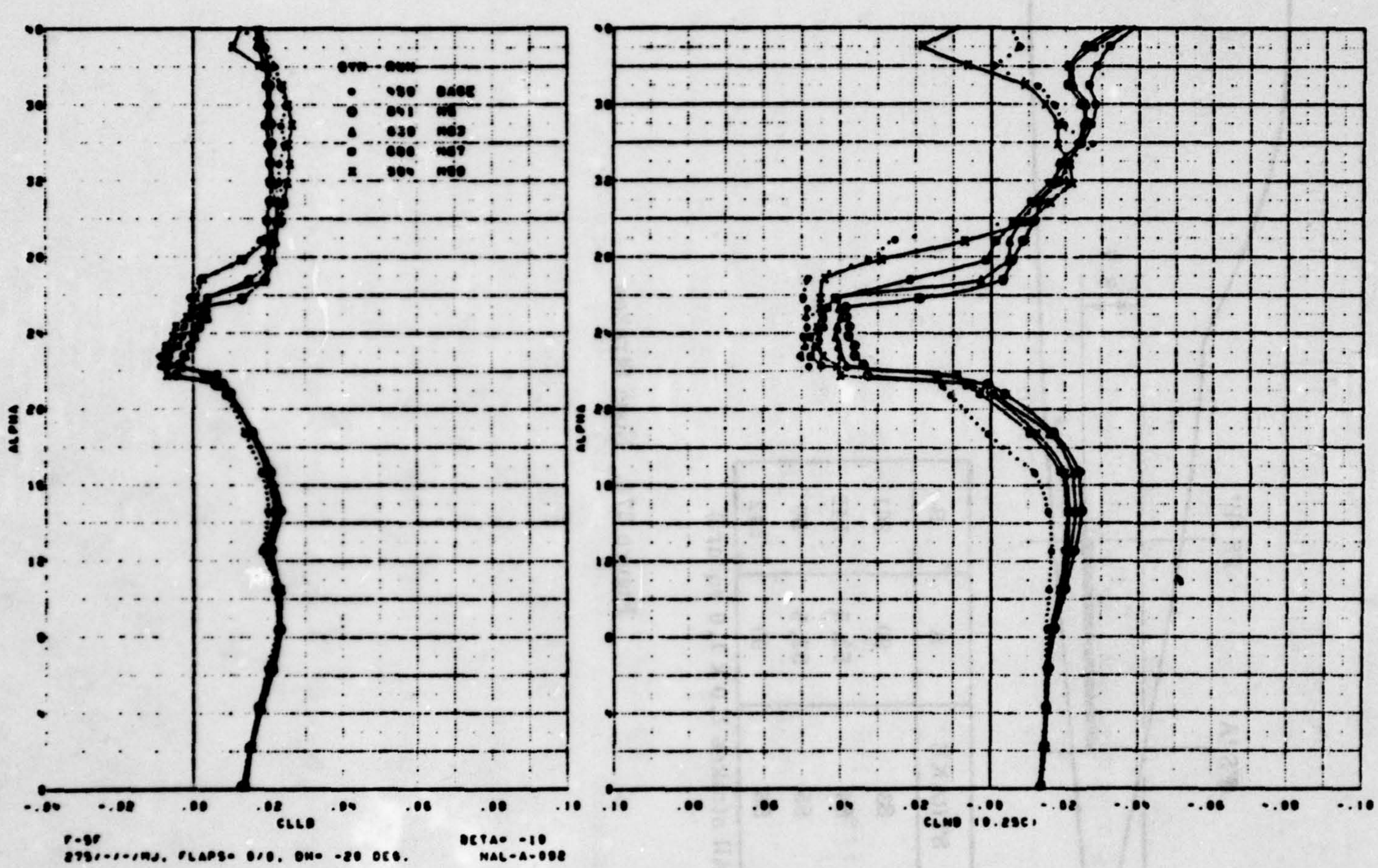


Figure 273. Effect of Nose Vortex Generators

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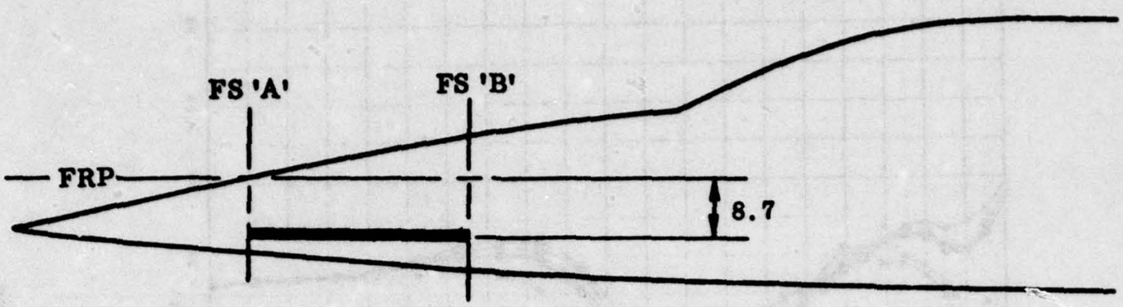

STRAKE	A	B
S3	90	201
S4	52.5	142
S5	52.5	90
S6	90	142

(All strakes 1.0 x 1.0 square)

Figure 274. Nose Strakes

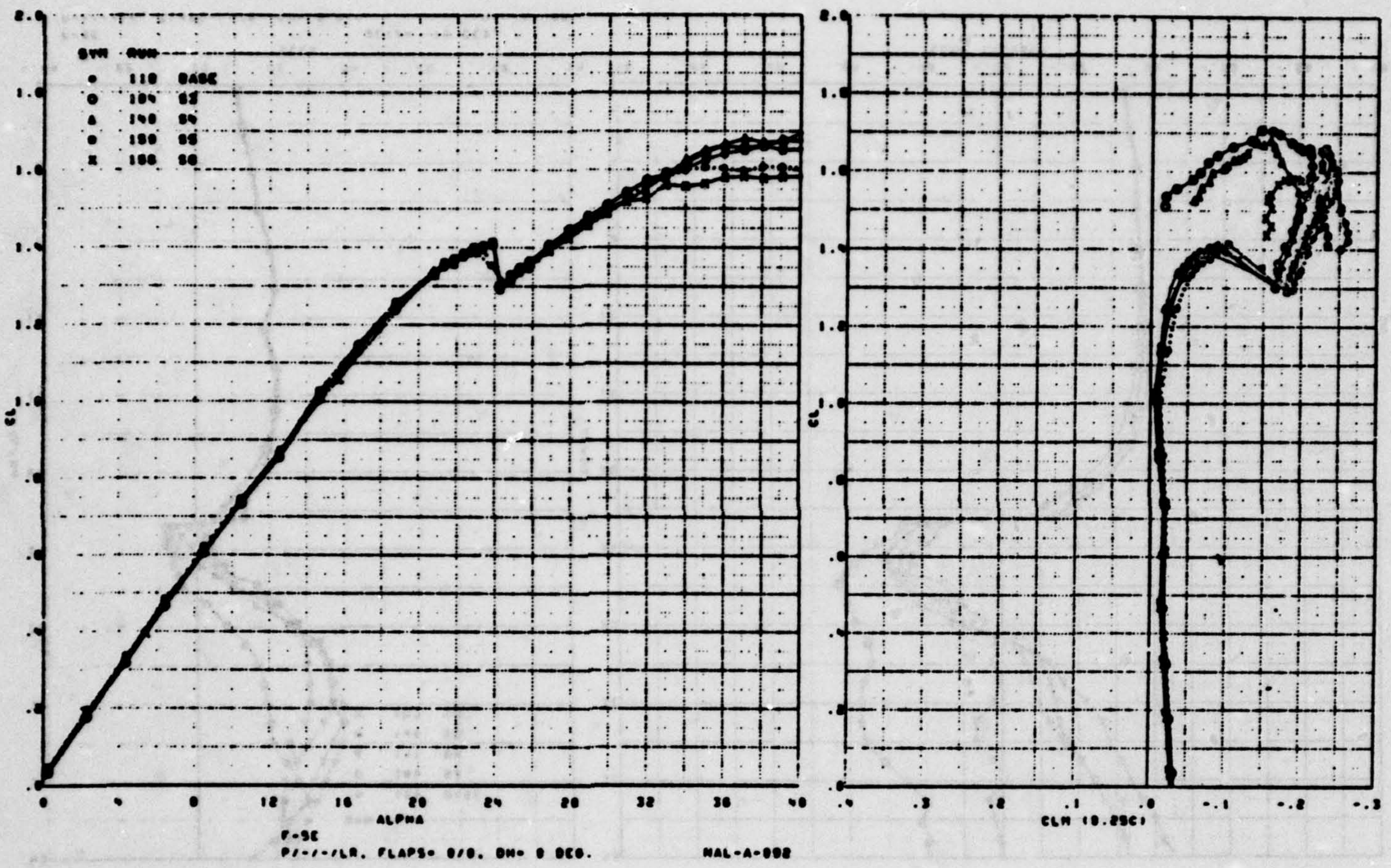

Figure 275. Effect of Nose Strakes

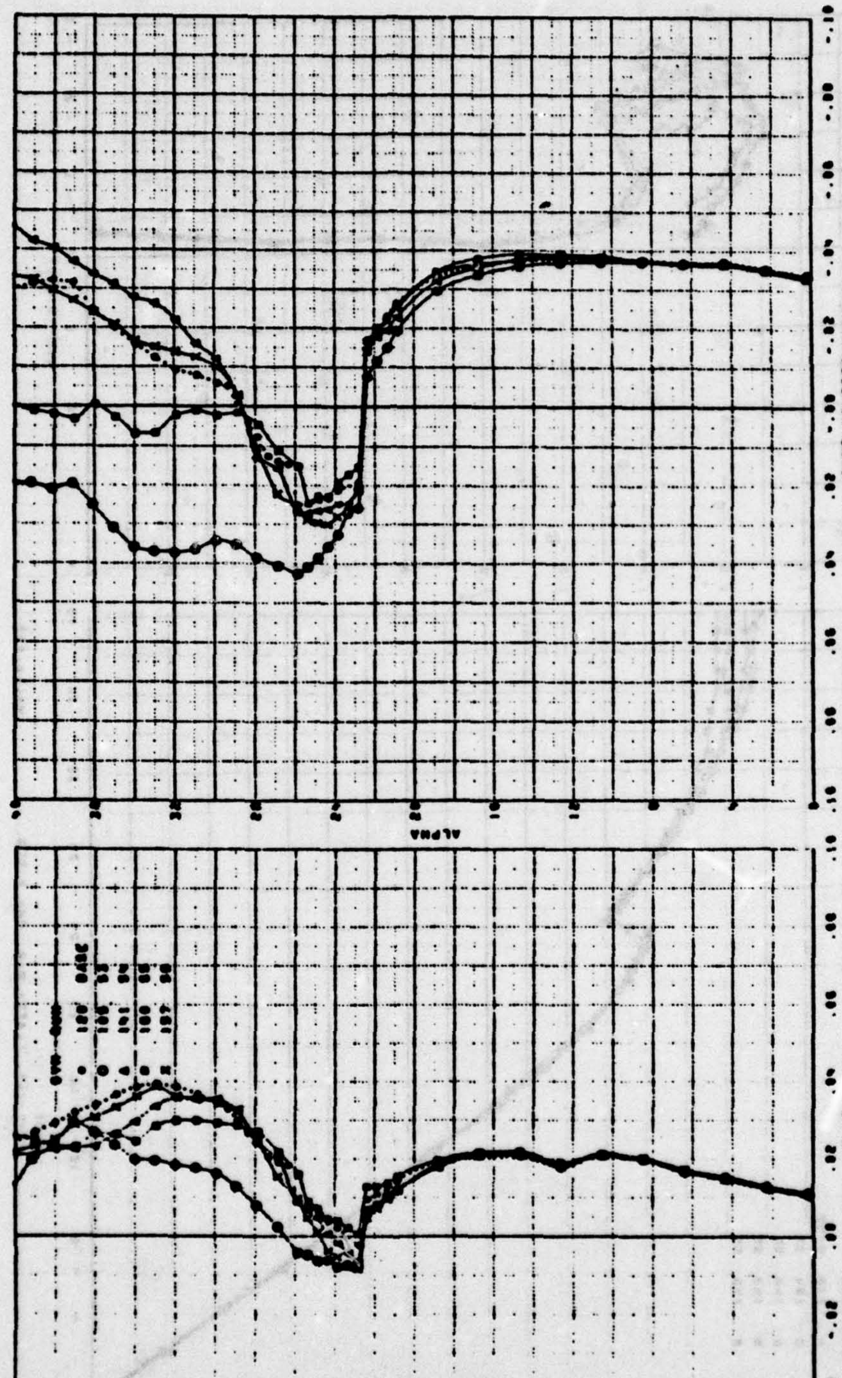

Figure 276. Effect of Nose Strakes

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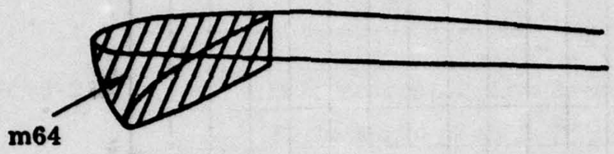

Figure 277. Flap Gap at Root (m64)

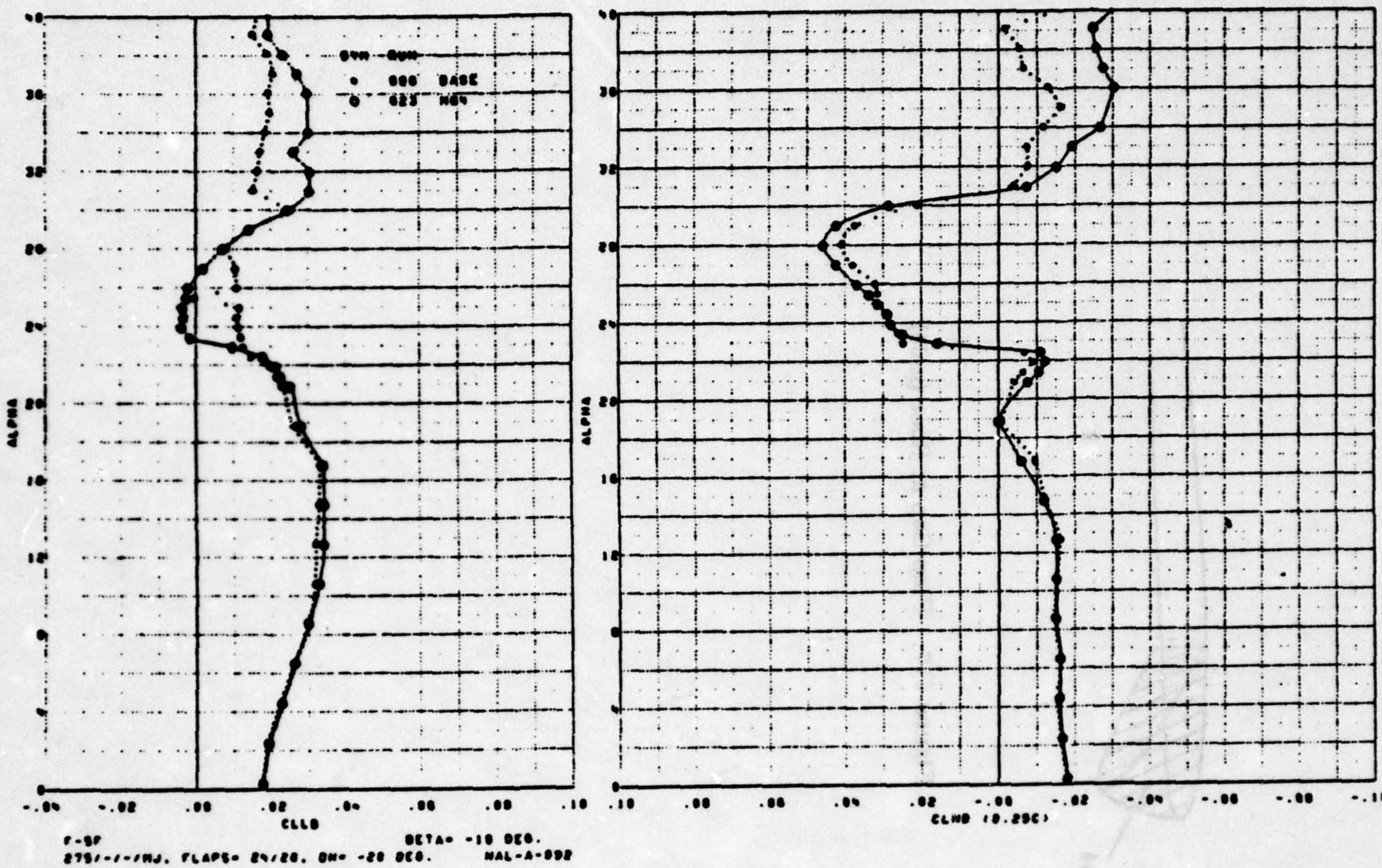

Figure 278. Effect of Closing Flap Gap

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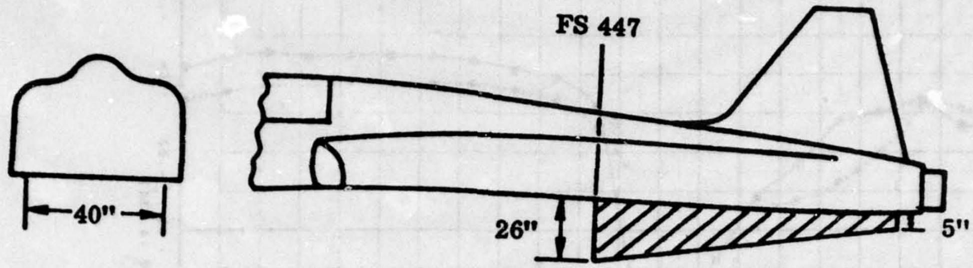


Figure 279. Twin Ventrals F11

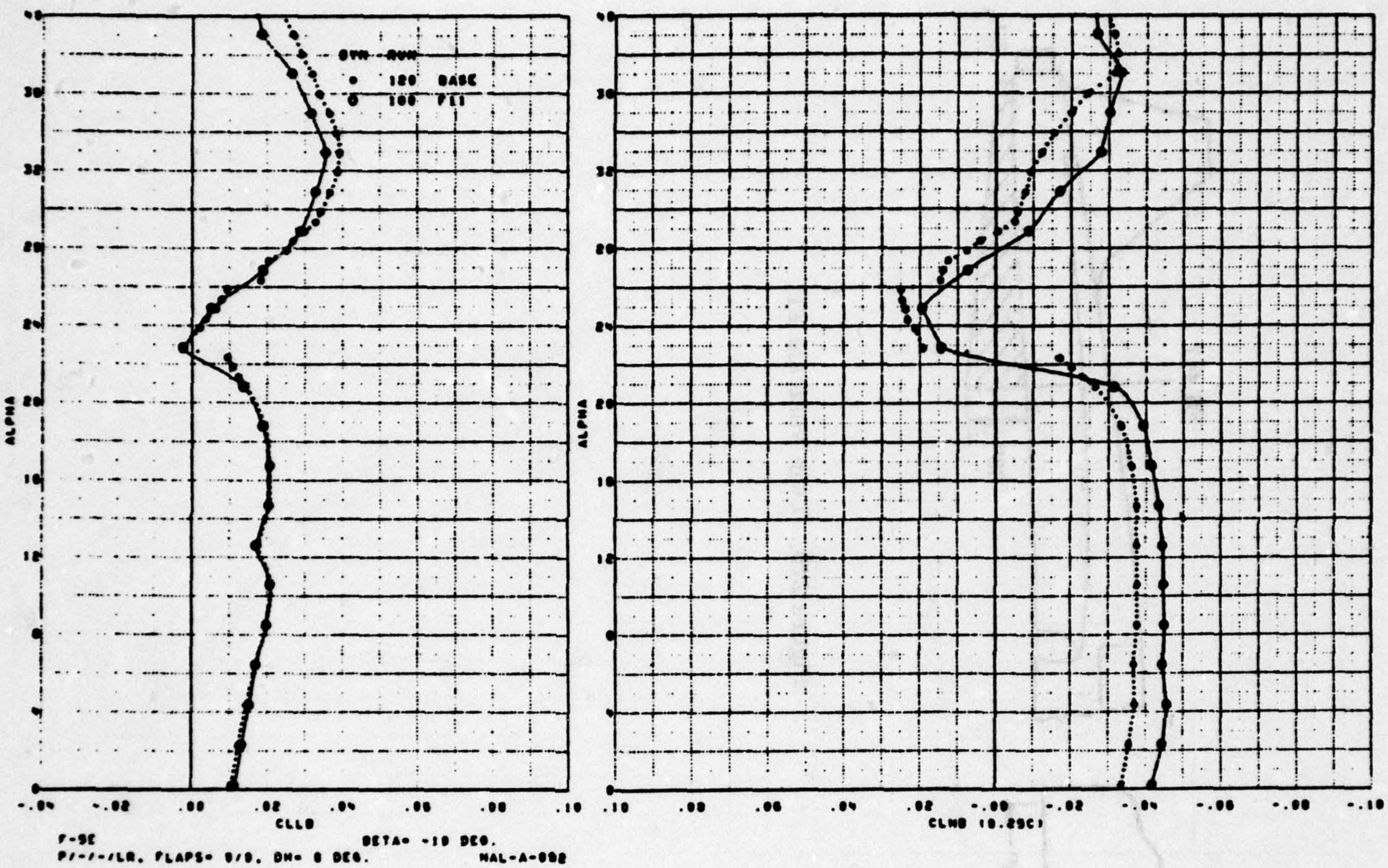


Figure 280. Effect of Twin Ventrals

AIRCRAFT	F-5E/F	REFERENCE	50

TEST REPORT

NOR 75-80 — Data Report of a Low Speed Wind Tunnel Test of a 10% Force Model of a F-5E in Deep Negative Pitch Attitudes and an F-5F with Wing Fences

G. B. Bennett — NAL-119

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 10% model of the F-5E/F airplane. A free-air test on a 10% scale metric model of the Multiple Ejection Rack (MER) employed by this F-5E model was also conducted. The test program was conducted during the time period from 10 through 20 February 1975.

The primary objectives of this test were to establish data for deep negative pitch and positive post-stall attitudes of the F-5E and to determine base data for the F-5F with an upper wing fence. Also determined were:

1. Effect of centerline tank, leading and trailing edge flaps, and wing fence on lateral-directional data.
2. The effects of a two-degree nose-down-tilt on store loads of a centerline SUU/20A Weapons Dispenser.
3. Force and moment data from a metric MER tested in free air.

TEST CONDITIONS

Mach No. = 0.26

R. N./Foot = 1.5×10^6

A. O. A. Range = -10° to 40°

Sideslip Range = 10 to -30°

AIRCRAFT CONFIGURATIONS

A basic model three view is shown in Figures 208 and 222.

CONFIGURATIONS CHANGES

Dimensions of the wing fence applicable to this study are shown in Figure 281.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 282 shows the effect on lateral/directional stability of upper surface wing fence m51.

Data effects for objectives 2 and 3 listed above was not considered pertinent.

FENCE	LOCATION	HEIGHT	LENGTH
m51	WS 81.5	3"	0-70%c

Figure 281. Upper Surface Wing Fence

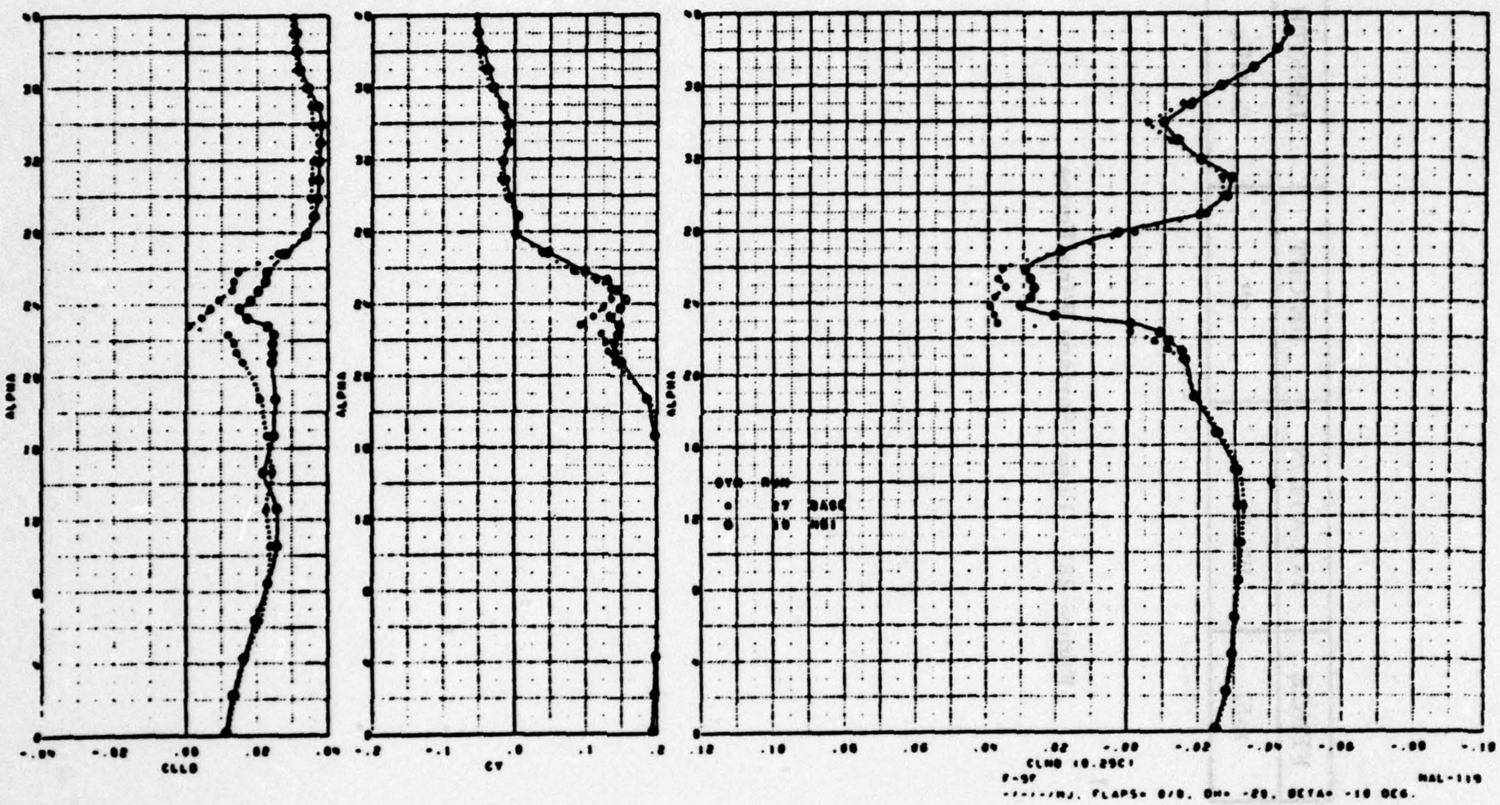


Figure 282. Effect of Wing Fences

AIRCRAFT F-5E/F REFERENCE 51

TEST REPORT

NOR 75-228 Data Report of a Low Speed Wind Tunnel Test of a 10% Force Model of an F-5E and F-5F with Maverick Missiles and Reconnaissance Forebodies

W. P. Rehm NAL-A-125

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 10% scale model of the F-5E/F and RF-5F airplanes. Phase I of this test program was conducted during the period of 6 May through 23 May 1975 and Phase II was conducted during the period 23 June through 16 July 1975.

A primary objective of this test program was to evaluate the Maverick missile effects on the aerodynamic characteristics of the F-5E/F configurations. Also of primary interest was aerodynamic data of various reconnaissance nose and reconnaissance bay window configurations at post-stall-gyration attitudes. Also determined were the effects of the following:

1. Fuselage - Ventral keel, dorsals, inlet duct 2-D devices, in-flight refueling probe, forebody mounted LATAR and FLIR pod, RHAW antennas, chaff dispenser and area ruling change body glove.
2. Horizontal Tail - Deflected tabs.
3. Wing leading Edge Extensions - Planforms, incidence angle.
4. Vertical Tail - Planforms, leading edge extension.
5. Wings - Fences, vortex generators, cambered leading edge sawtooths and snags.

TEST CONDITIONS

Mach No. = 0.26

R. N./Foot = 1.5×10^6

A. O. A. Range = -10° to 40°

Sideslip Range = 0° to -20°

AIRCRAFT CONFIGURATIONS

A basic model three view is shown in Figures 208 and 222.

CONFIGURATION CHANGES

Sketches of leading edge sawtooth, leading edge extension, inlet cowl and dorsal configuration changes applicable to this study are shown in Figures 283, 286, 287 and 293.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figures 282 and 285 show the effect on longitudinal and lateral/directional stability of leading edge sawteeth, W35, W36, and W37.

Figure 287 shows the effect on $C_{L_{MAX}}$ of LEX angle of attack and Figure 288 shows the effect on $C_{L_{MAX}}$ of LEX planform, W6, W7, W8, W29, W31 and W33.

Longitudinal and lateral/directional stability data is shown in Figures 290 and 291 for the effect of inlet cowl D8 and D9. The effect on $C_{L_{MAX}}$ is shown in Figure 292.

Figure 294 shows the effect on lateral/directional stability of dorsal V9.

Data effects for objective 2 listed above was not considered pertinent.

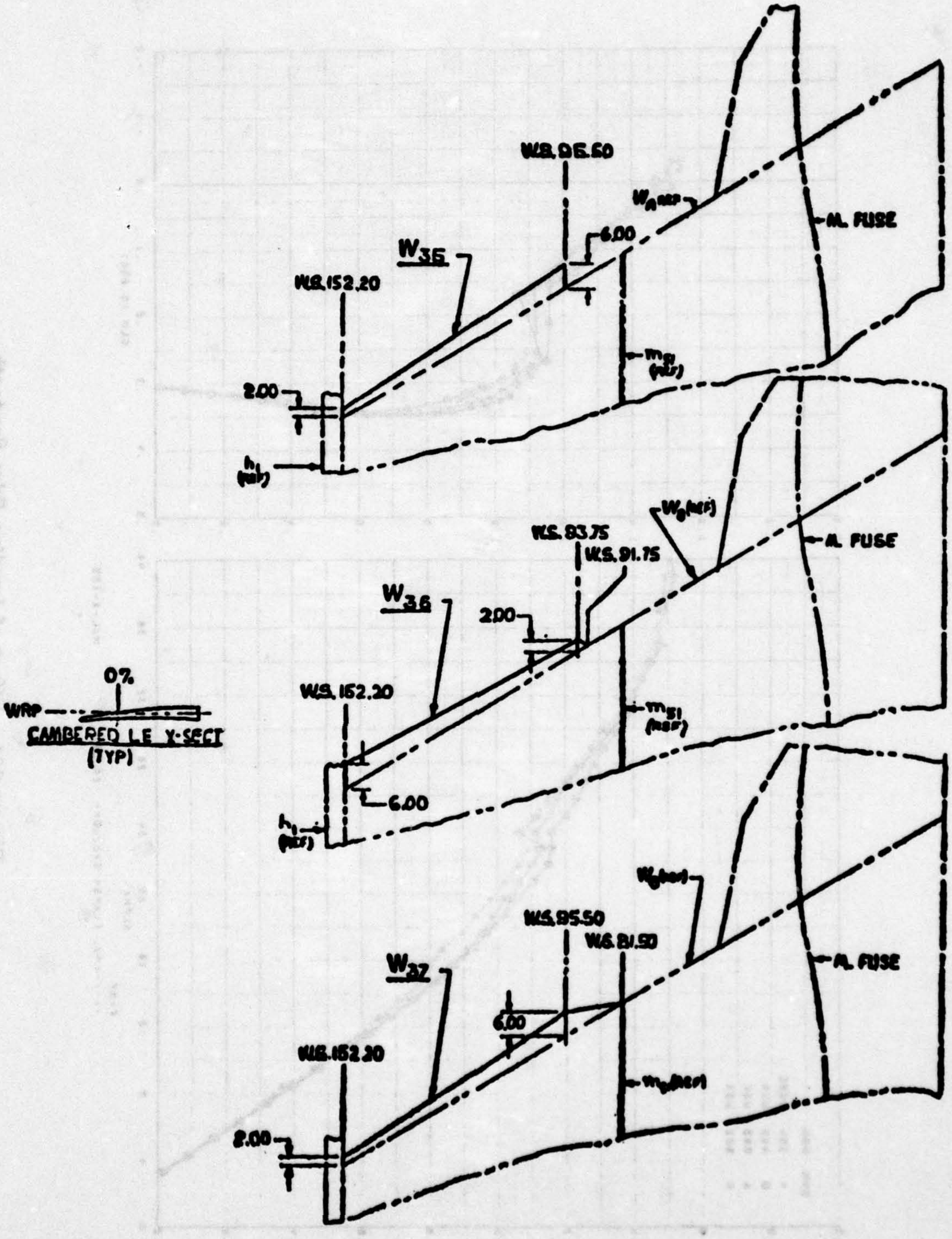


Figure 283. Leading Edge Sawtooth

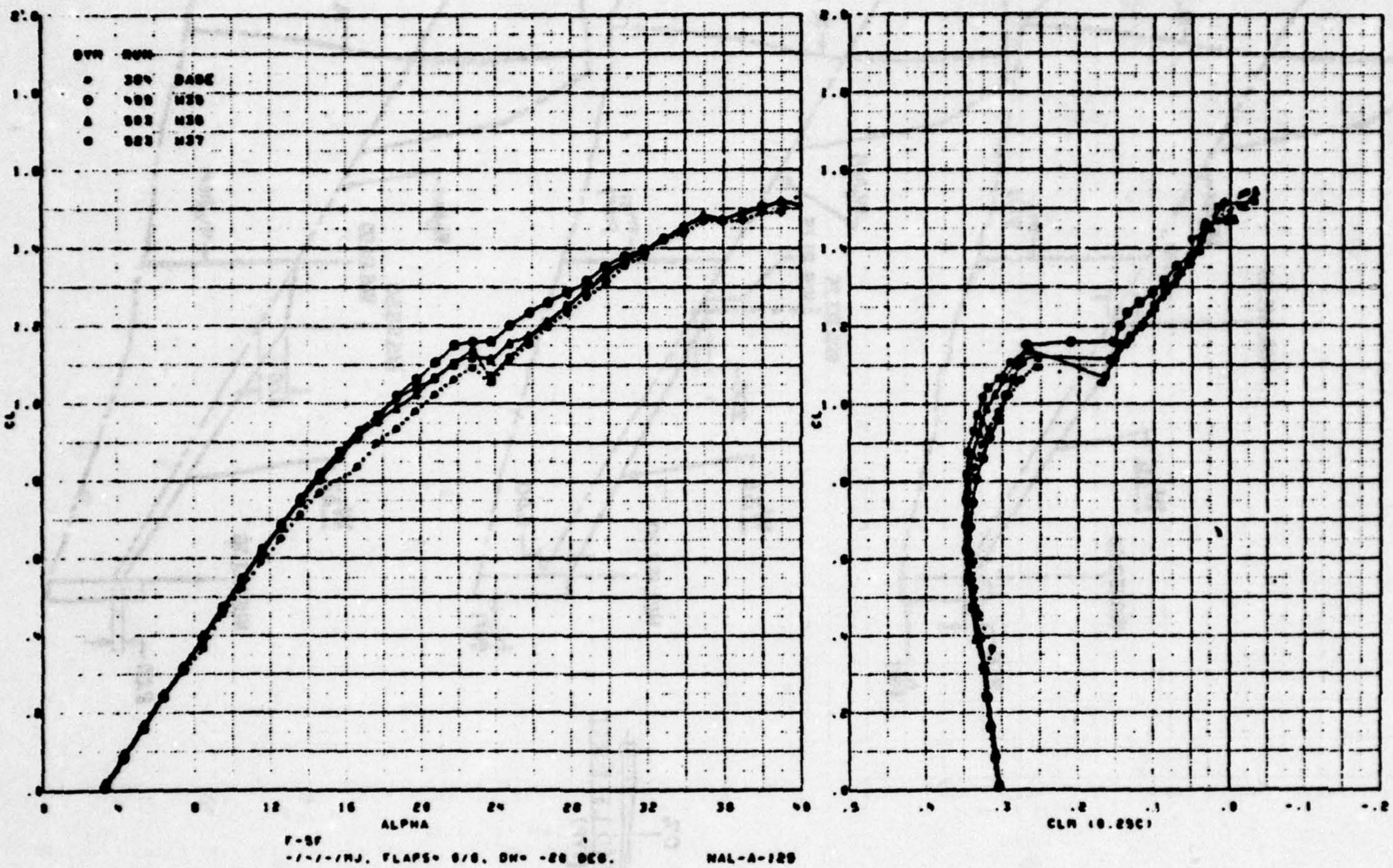


Figure 284. Effect of Leading Edge Sawtooth

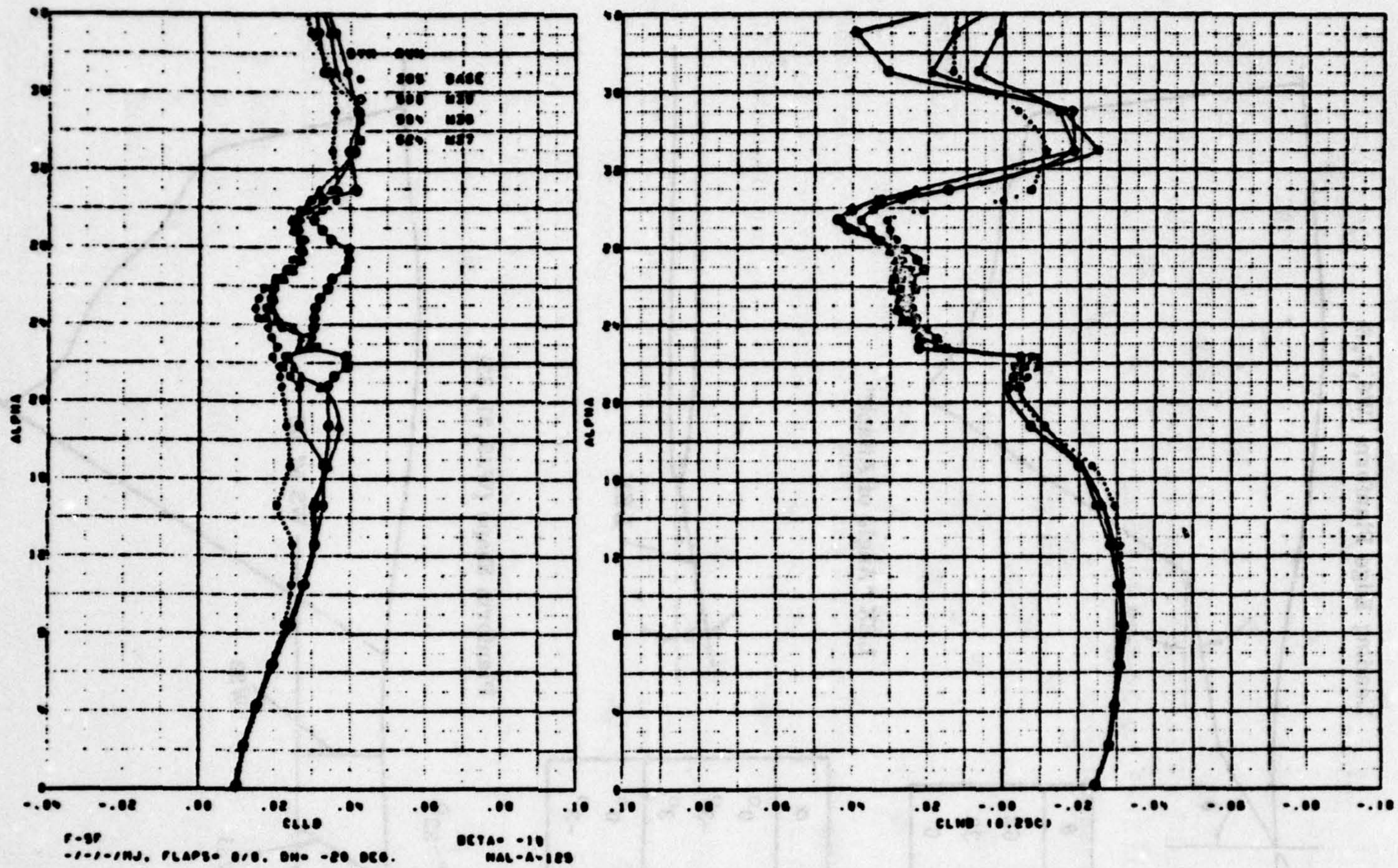
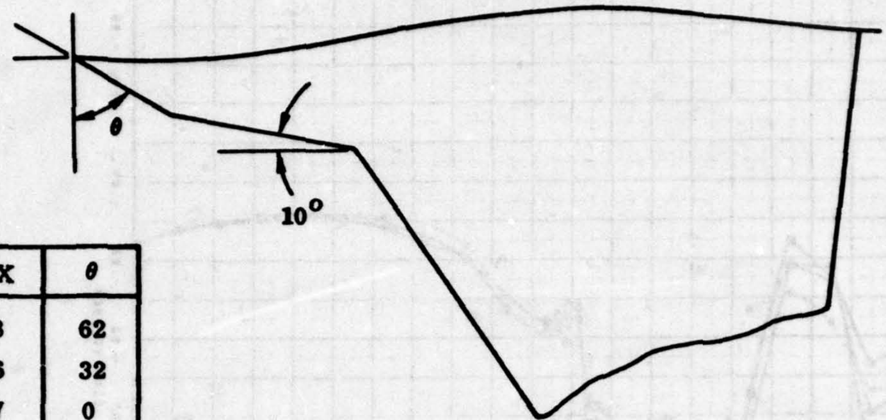


Figure 285. Effect of Leading Edge Sawtooth

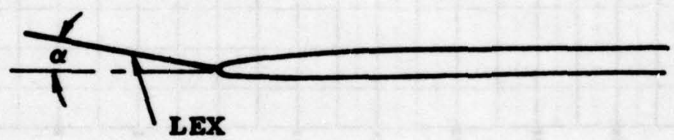
Leading Edge Planform (W6, 7, 8)



LEX	θ
W8	62
W6	32
W7	0

LEX "Angle of Attack"

LEX	α
W6	0°
W32	-3°
W34	3°
W8	0°
W28	-3°



Planform Shape (W29, 31, 33)

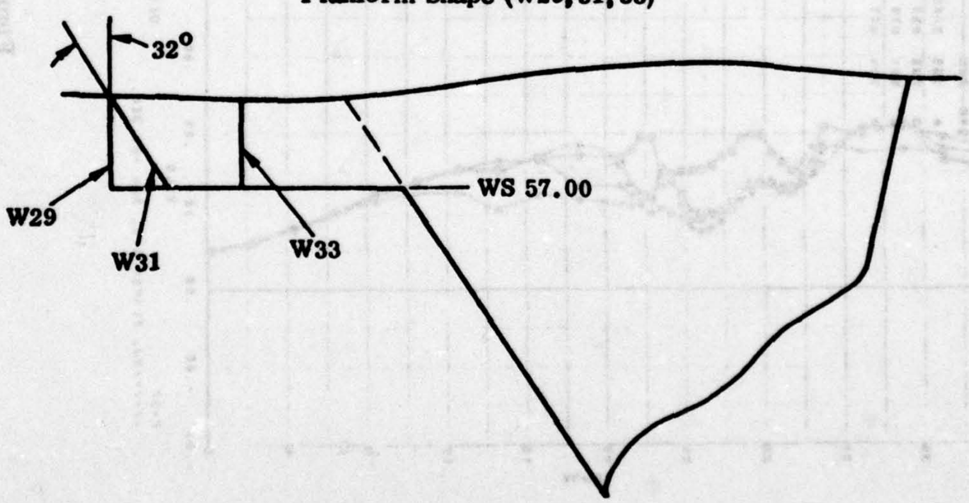


Figure 286. Lex Leading Edge Planform, Lex Angle of Attack, Lex Planform Shape

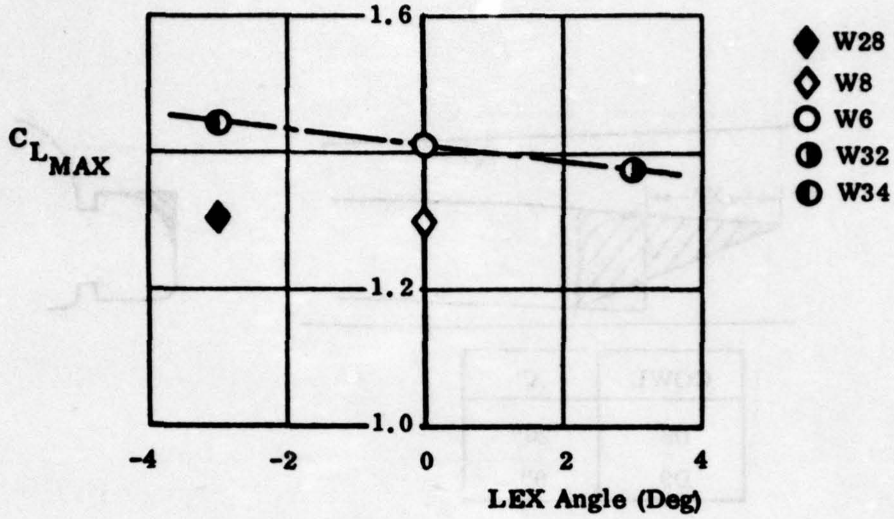


Figure 287. Effect of Lex Angle of Attack

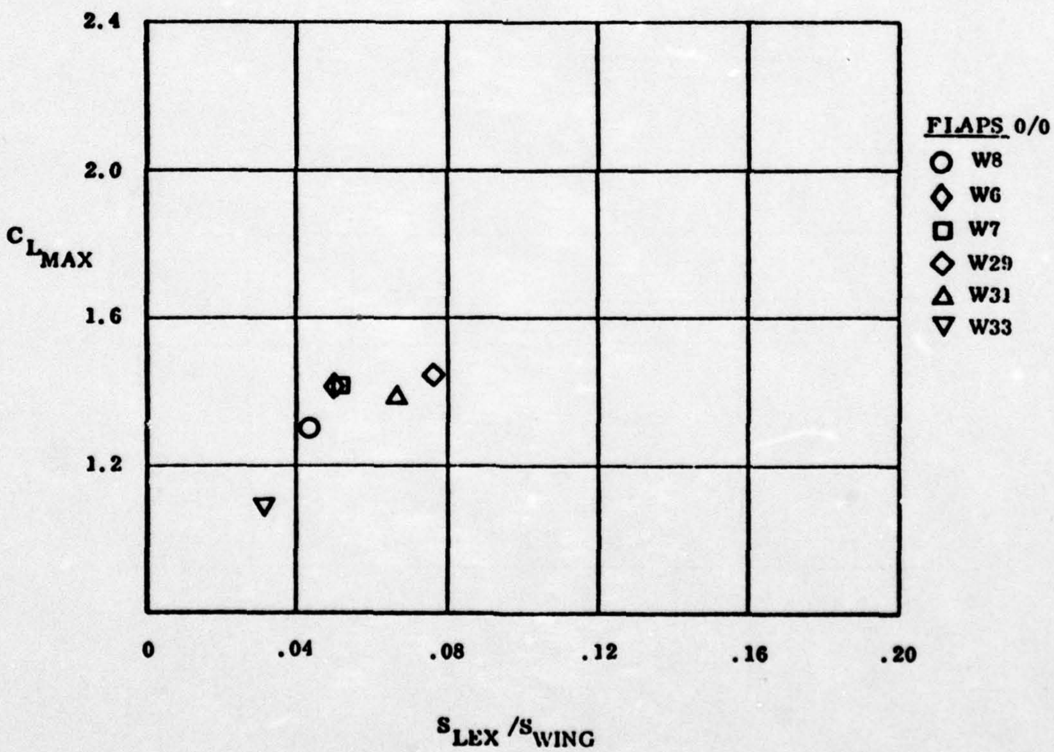
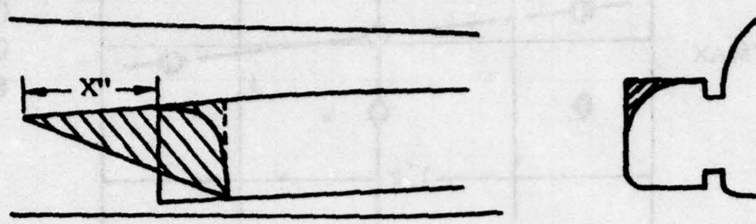


Figure 288. Effect of Lex Planform



COWL	X"
D8	20"
D9	0"

Figure 289. 2D Inlet Cowls

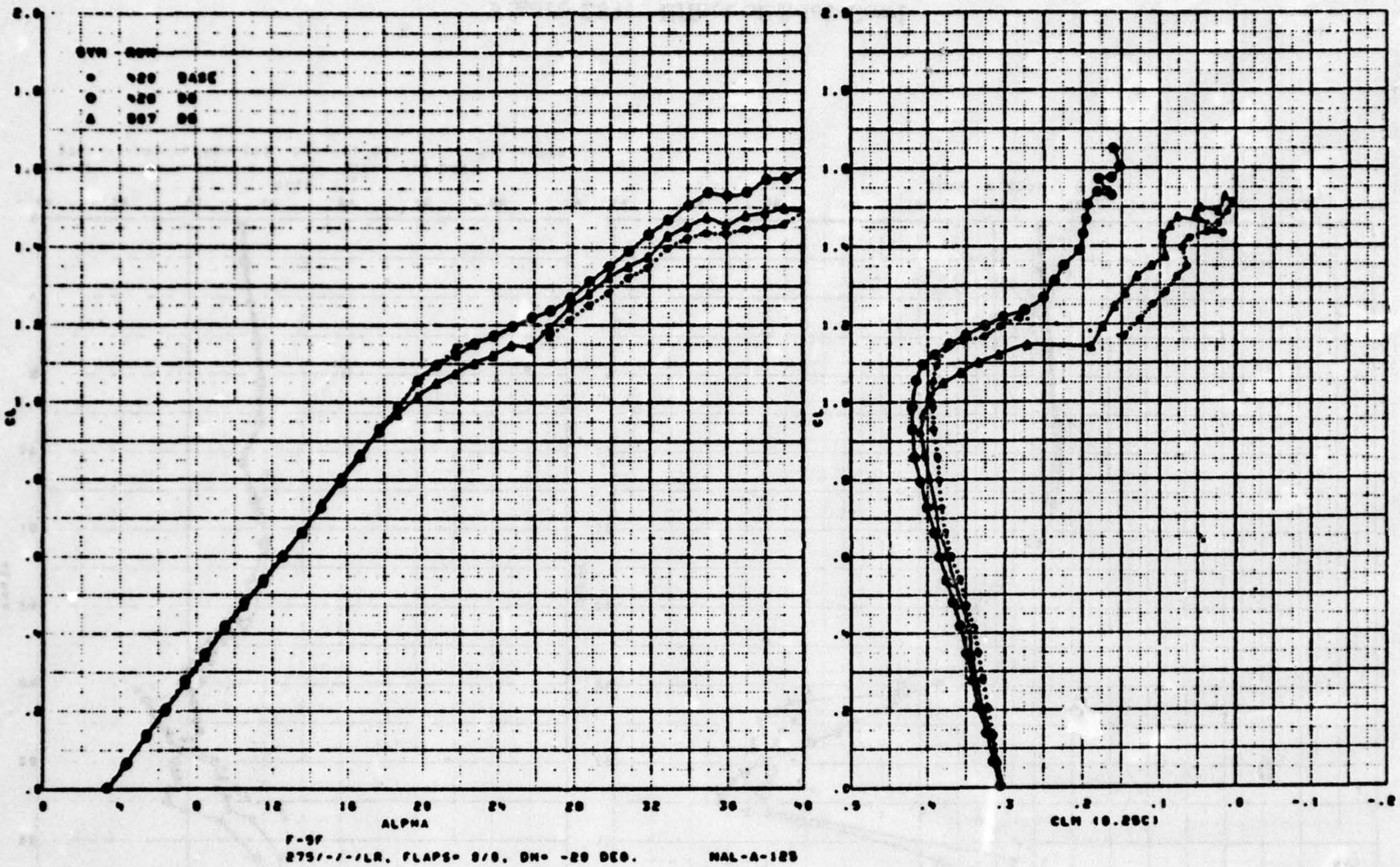


Figure 290. Effect of Inlet Cowl

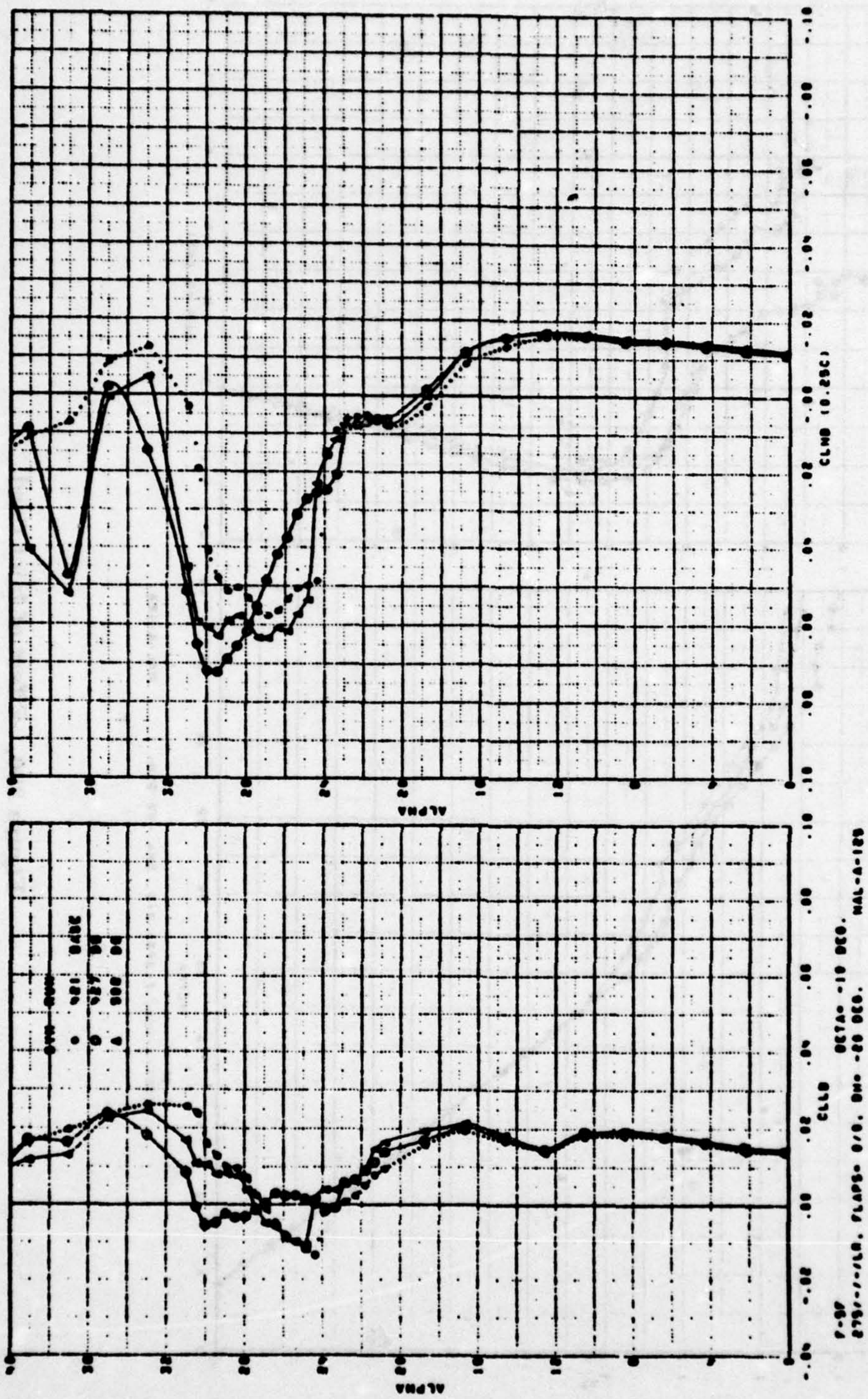


Figure 291. Effect of Inlet Cowl

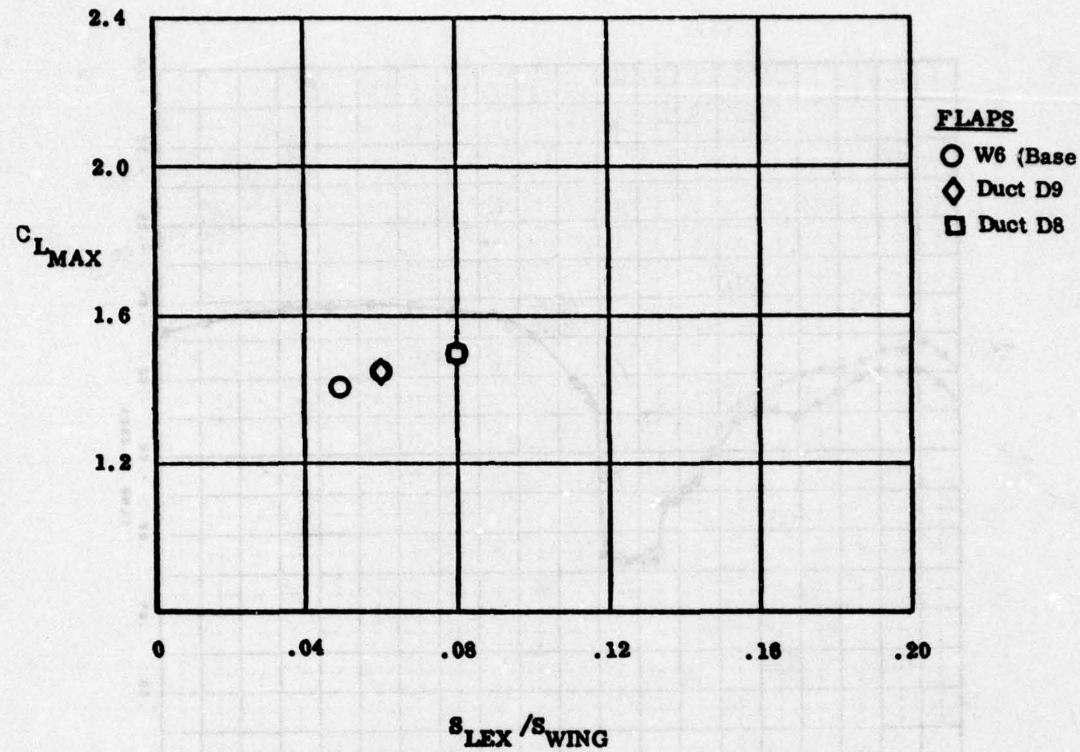


Figure 292. Effect of Inlet Cowl

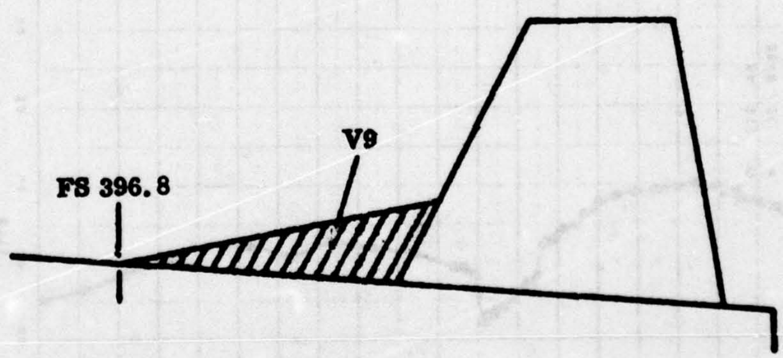


Figure 293. Dorsal V9

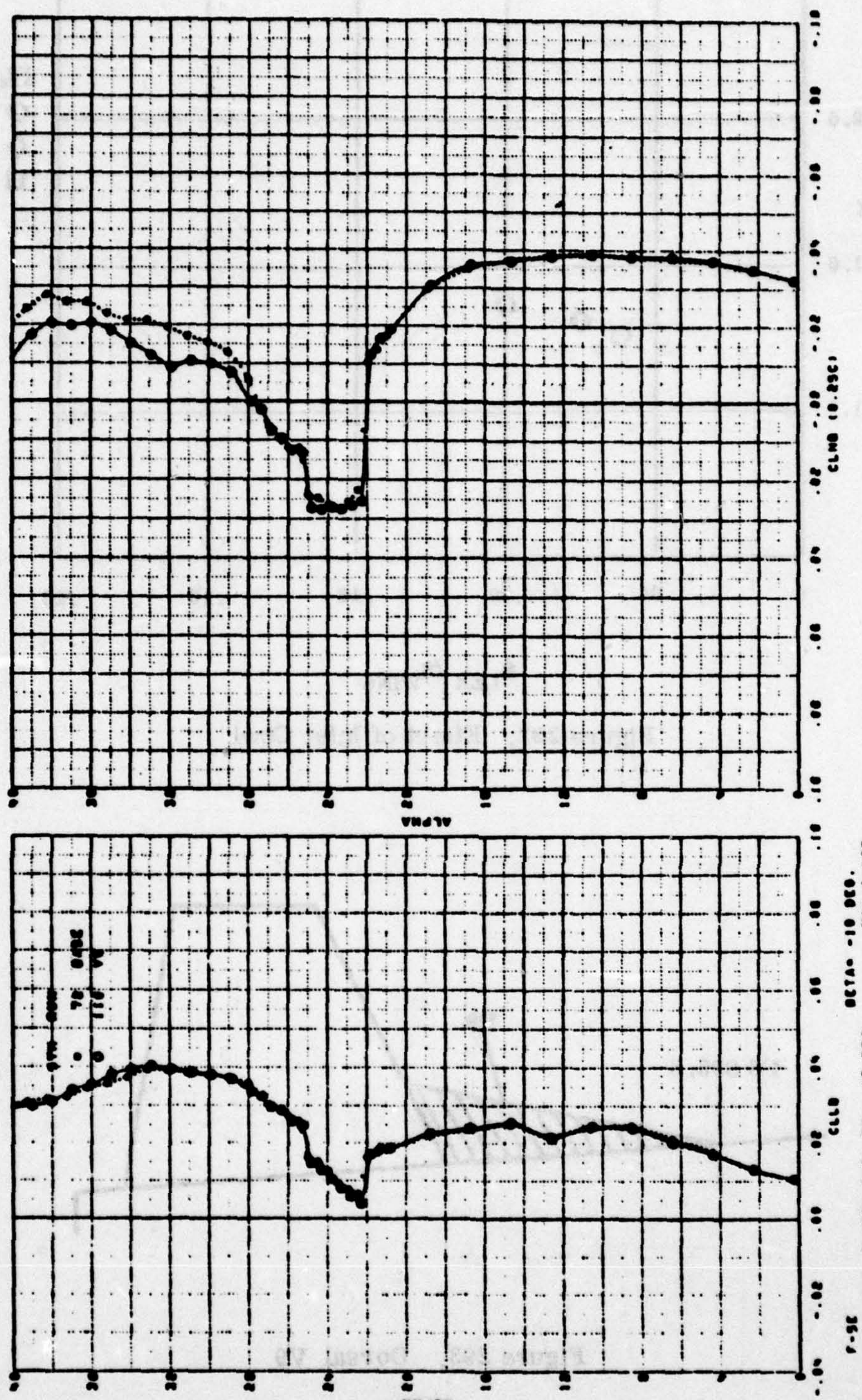


Figure 294. Effect of Dorsal V9

AIRCRAFT **F-5E/F** REFERENCE **52**

TEST REPORT

NOR 75-191 **Data Report of a Low Speed Wind Tunnel Test of a 10% Force Model of an F-5E and F-5F and a 10% Force Model of an AGM-65A Maverick Missile**

R. A. Dawson NAL-140

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 10% model of the F-5E and F-5F airplanes and a 10% model of the AGM-65A Maverick Missile. The test program was conducted during the period 17 September through 8 October 1975.

The objectives of the test were to determine the effects of the following:

1. F-5E - Reconnaissance and radar noses; centerline ECM pods; LEX configuration; centerline tank and pylon; vertical tail, including a tufted grid for flow visualization.

2. F-5F - Segmented leading edge flap, leading edge sawtooths and slats; leading edge extension configuration; vertical tail, wing fence, and centerline tank and pylon.

TEST CONDITIONS

Mach No.	= 0.26
R. N./Foot	= 1.5×10^6
A. O. A. Range	= -10° to 40°
Sideslip Range	= 0, -10°

AIRCRAFT CONFIGURATION

A basic three view is shown in Figures 208 and 222.

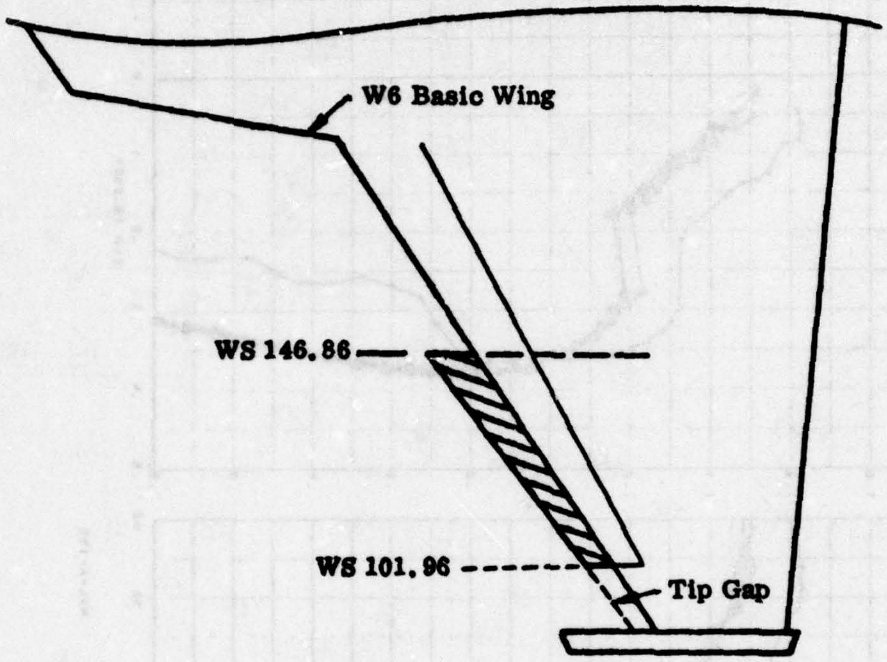
CONFIGURATION CHANGES

Sketches of wing sawteeth and leading edge flap configuration changes applicable to this study are shown in Figures 295 and 298.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figures 296 and 297 show the effect on longitudinal and lateral/directional stability of leading edge sawteeth on basic wing W6. Wimilar data is shown in Figures 299 and 300 for various inboard/outboard deflections of a two segment, leading edge flap on wing W1. Leading edge/trailing edge flap deflection was 24°/20°.

Data effects for other items listed above was either insufficient or not considered pertinent.



WING	%c	CAMBER	$\Delta C_{L_{MAX}}$	
			FLAPS UP	FLAPS 24*/20
W39	10%	3.5%	0.01	0.01
W40	5%	2.2%	0.0	0.01
W41	10%	Flat	0.0	0.0
W42	10%	3.5%	—	0.02
W43	5%	—	0.0	—

*Inboard Flap Only

Figure 295. Sawtooth Leading Edge

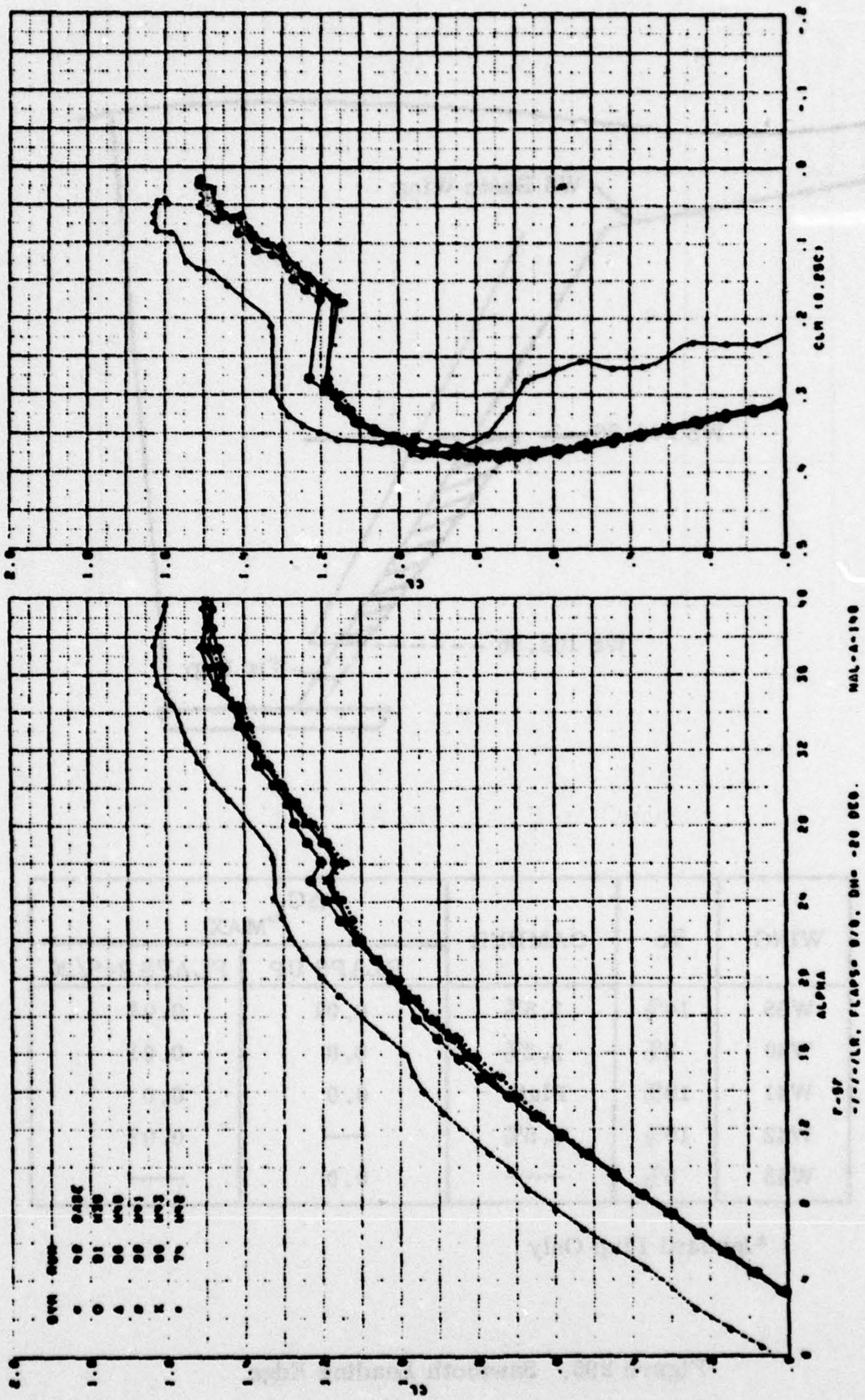


Figure 296. Effect of Leading Edge Sawtooth

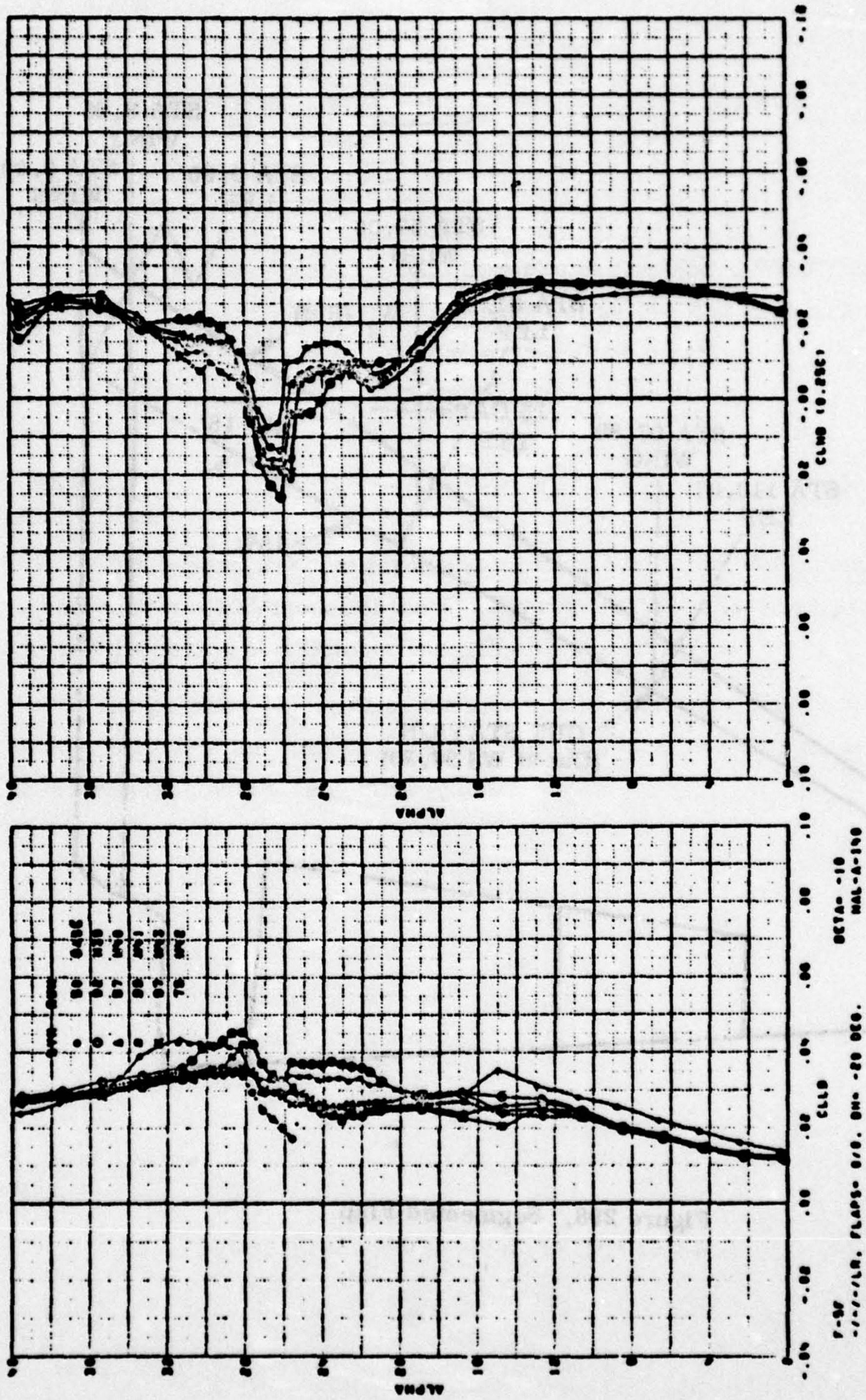


Figure 297. Effect of Leading Edge Sawtooth

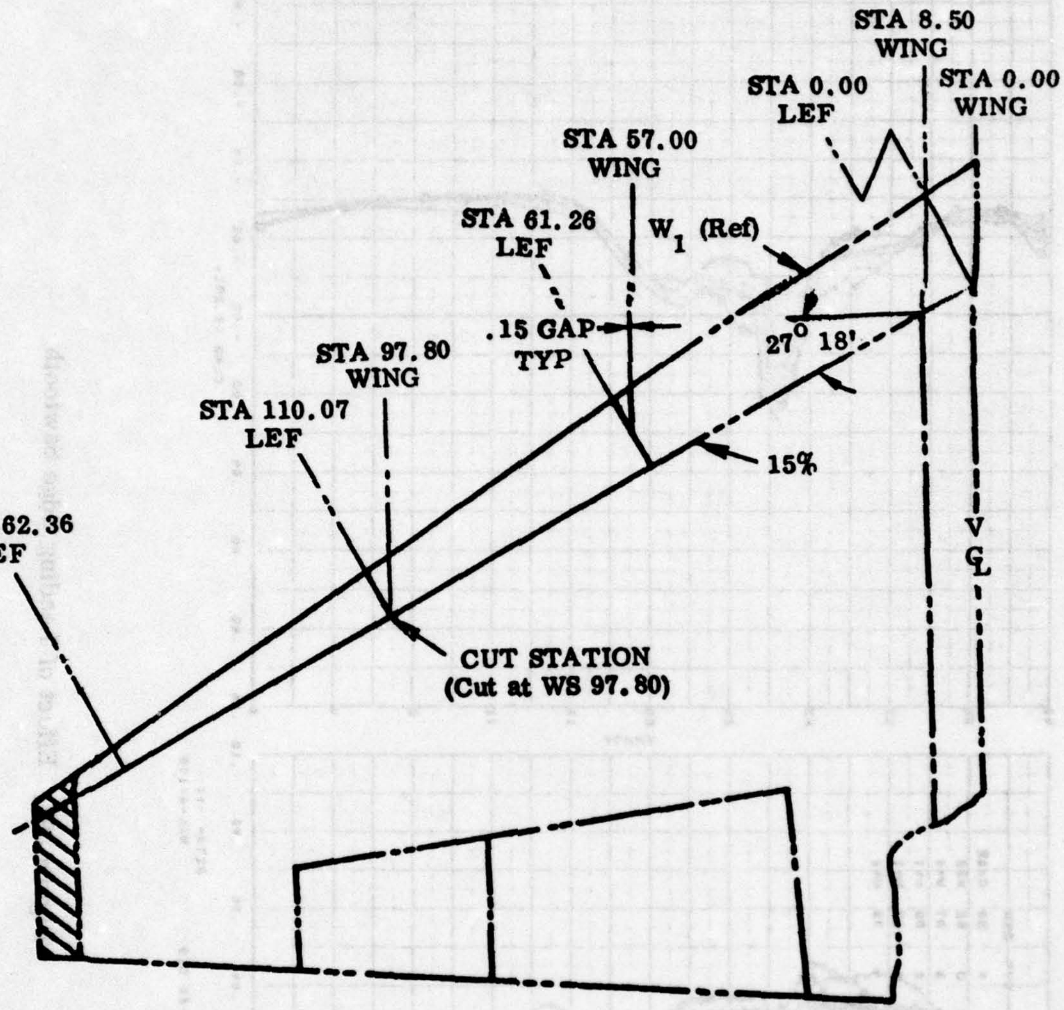


Figure 298. Segmented Flap

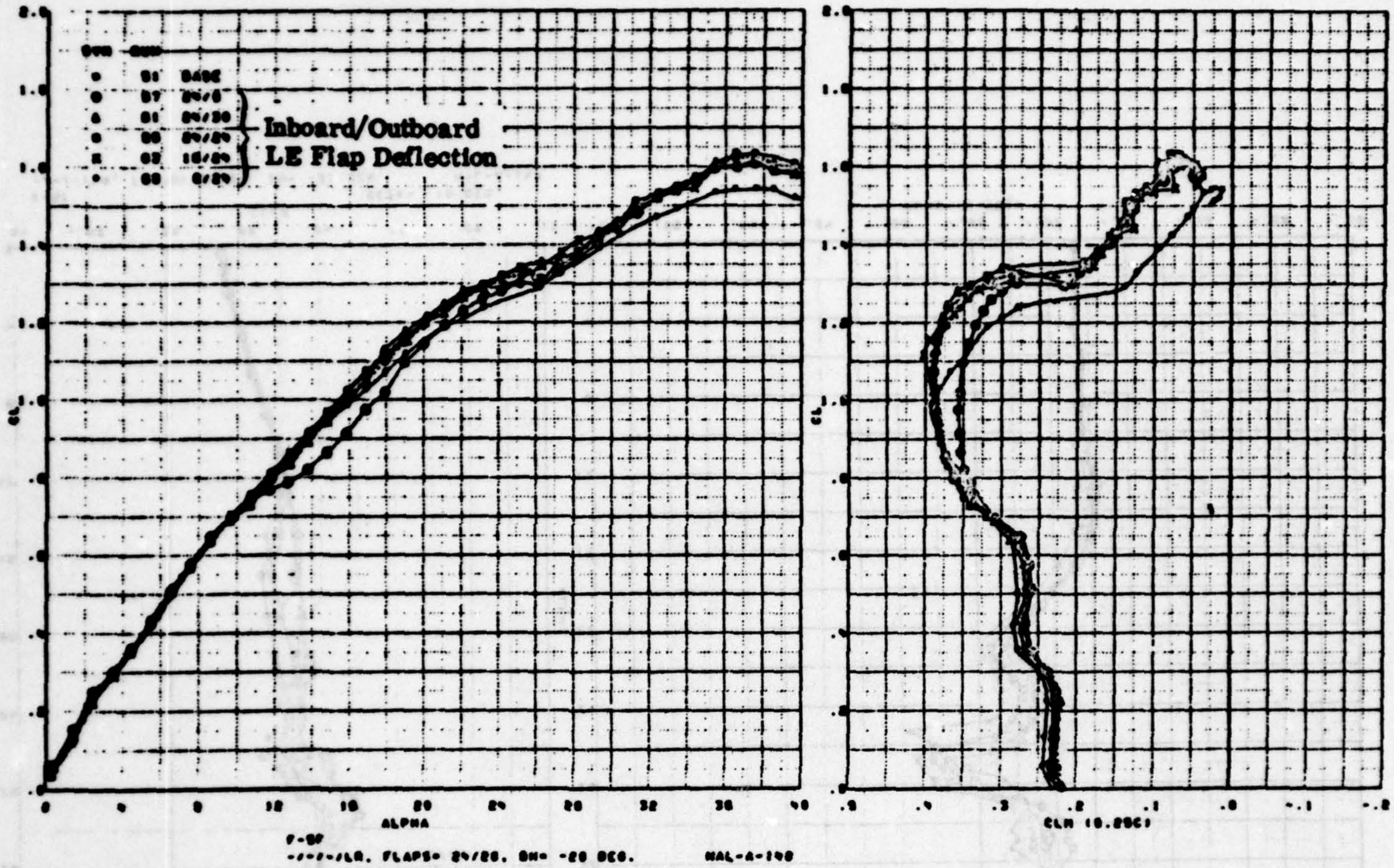


Figure 299. Effect of Segmented Flaps

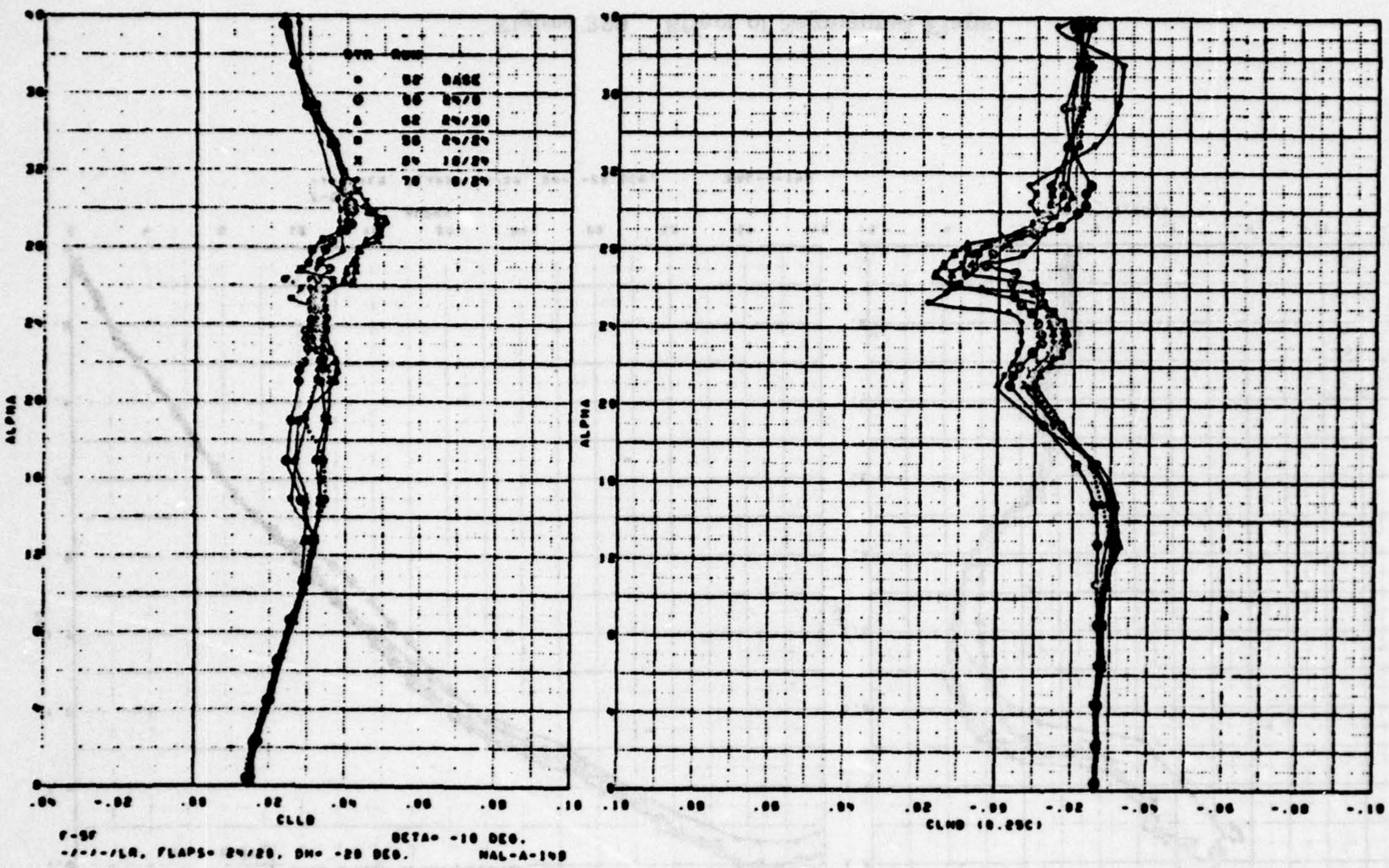


Figure 300. Effect of Segmented Flaps

AIRCRAFT **F-5E** **REFERENCE** **53**

TEST REPORT

NOR 76-65 **Data Report of a Low Speed Wind Tunnel Test of a 10 Percent Force Model of a F-5E with a Modified Leading Edge Extension**

E. G. Kontos **MAL-155**

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 10% model of an F-5E airplane. The test program was conducted during the period 18 February through 9 March 1976.

The objectives of the test were the following:

1. **Obtain basic data on the standard F-5E from α = -40° to 40°.**
2. **Obtain basic data on the F-5E airplane with a modified leading edge extension (LEX).**

TEST CONDITIONS

Mach No.	=	**0.26**
R. N./Foot	=	**1.5 x 10^6**
A. O. A. Range	=	**-40° to 40°**
Sideslip Range	=	**10° to -20°**

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 208.

CONFIGURATION CHANGES

Sketches of leading edge camber configuration changes applicable to this study are shown in Figure 301.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 302 shows the effect on $C_{L_{MAX}}$ of leading edge extension camber W6 and W44.

LEX	θ
W6	0^{o}
W44	8^{o}

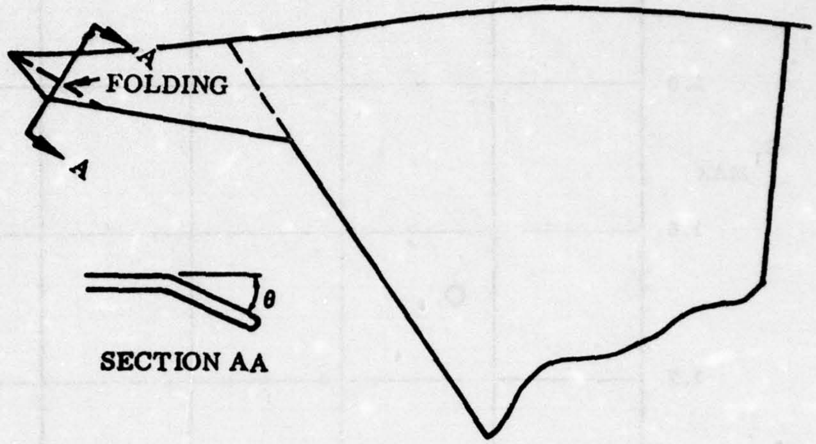


Figure 301. Lex Camber Variation

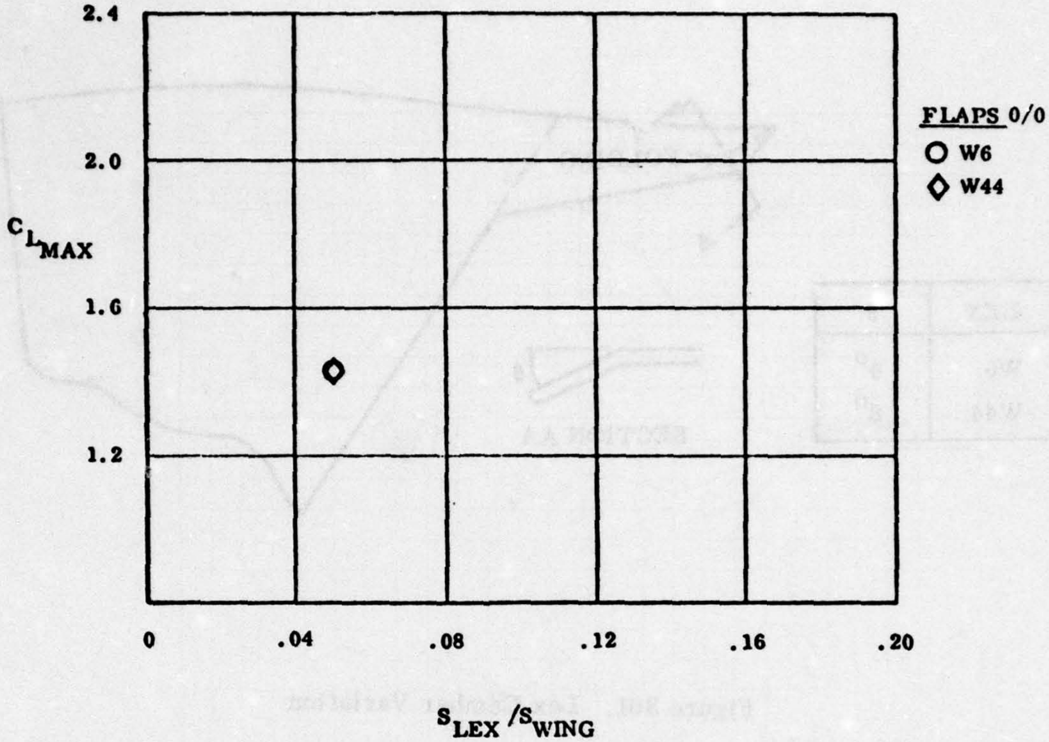


Figure 302. Effect of Lex Nose Camber

AIRCRAFT **F-5F** REFERENCE **54**

TEST REPORT

NOR 76-212 — Data Report of a Low Speed Wind Tunnel Test of a 10% Force Model of an F-5F at High Attitudes with Various Radome Nose Configurations

G.B. Bennett — NAL-179

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 10% model of the F-5F airplane. The test program was conducted during the period of 6 October through 16 October 1976.

The primary objective of the test was to determine directional stability trends at high attitudes for various nose radome configurations on a model of the production F-5F airplane with a centerline pylon.

TEST CONDITIONS

Mach No. = 0.26

R.N./Foot = 1.5×10^6

A.O.A. Range = Various

Sideslip Range = Various

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 222.

CONFIGURATION CHANGES

Sketches of nose angle, nose bluntness, nose broadness, miscellaneous strakes and nose strake configuration changes applicable to this study are shown in Figures 303, 310, 311, 312, 321, 322.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figures 305 through 308 shows the effect on longitudinal and lateral/directional stability of various nose radii, B20, B21, B22, B23, and B24.

Figure 309 shows the effect on lateral/directional stability of various nose angles, B20, B27 and B28.

Figure 313 and 314 shows the effect on zero sideslip data and lateral/directional stability of nose bluntness, B20 and B26.

Similar data is shown in Figures 316 and 317 for the shark nose. Figure 318 shows the longitudinal data for this shark nose.

Figures 319 and 320 show the effect on lateral/directional and pitching moment data at zero sideslip of nose bluntness B11 and B20.

Figures 323 through 328 show the effect of pitot strake S7 on longitudinal, pitching moment and lateral/directional data at zero and -10° sideslip. A similar batch of data is shown in Figures 329 through 334 for vertical and rearward strakes S8, S9 and m63, and in Figures 335 through 340 for lower strake S11.

Finally, the effect of strake length and strake fairing, S10, S12, S13 and S14 on longitudinal, pitching moment and lateral/directional data is shown in Figures 341 through 352.

NOSE	RADIUS INCHES
B20	0
B21	2.0
B22	3.0
B23	4.0
B24	5.0

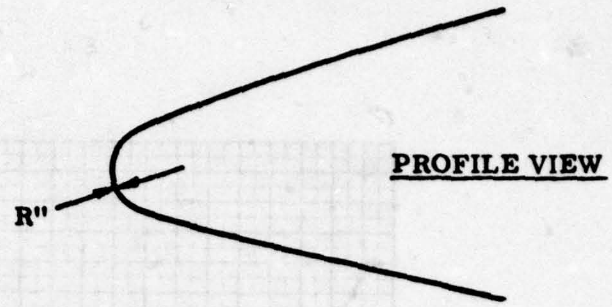


Figure 303. Nose Radius

NOSE	θ
B20	25°
B28	45°
B27	90°

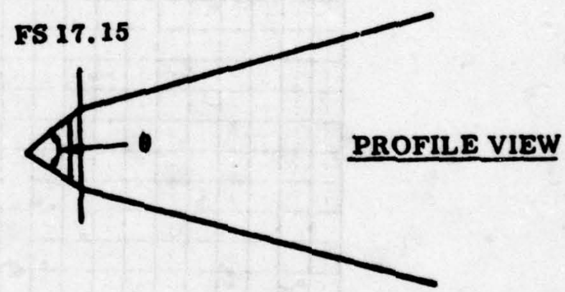


Figure 304. Nose Angle

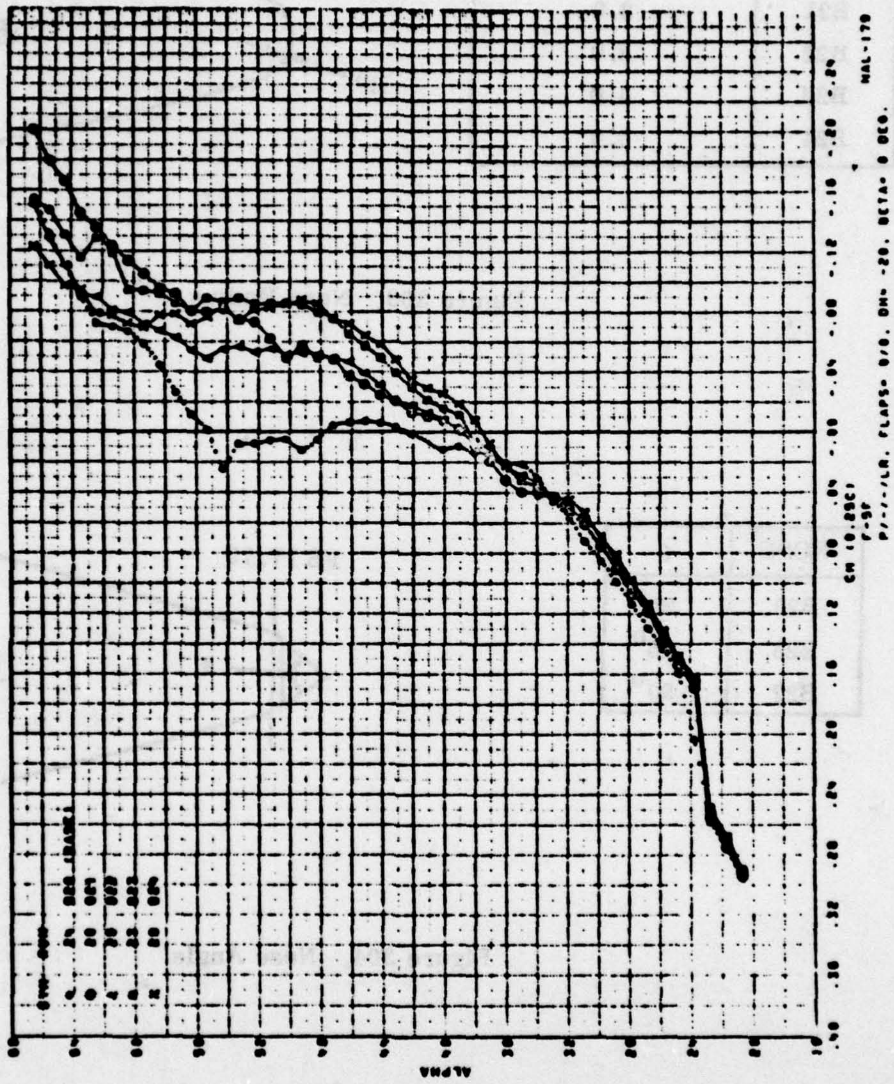


Figure 305. Effect of Nose Radius

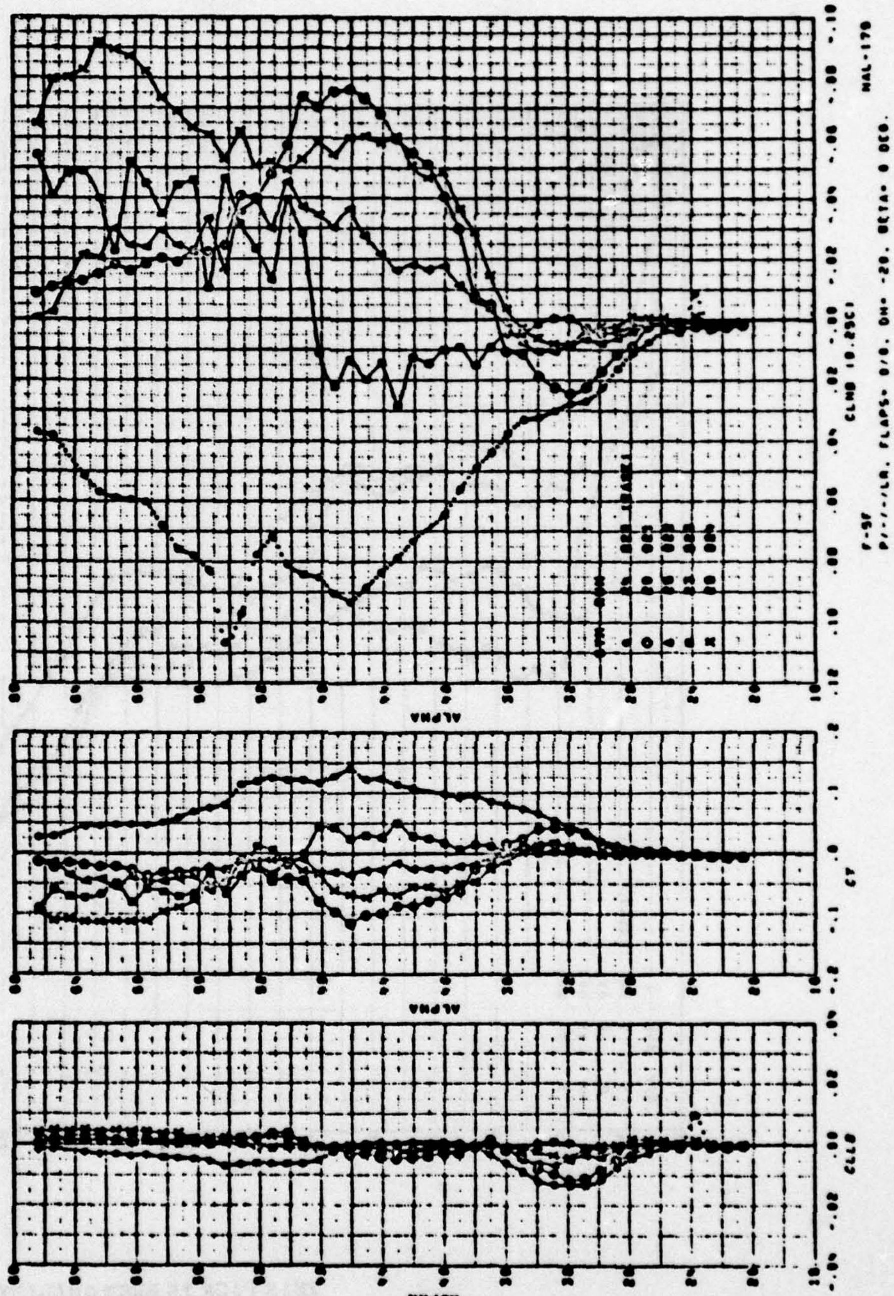


Figure 306. Effect of Nose Radius

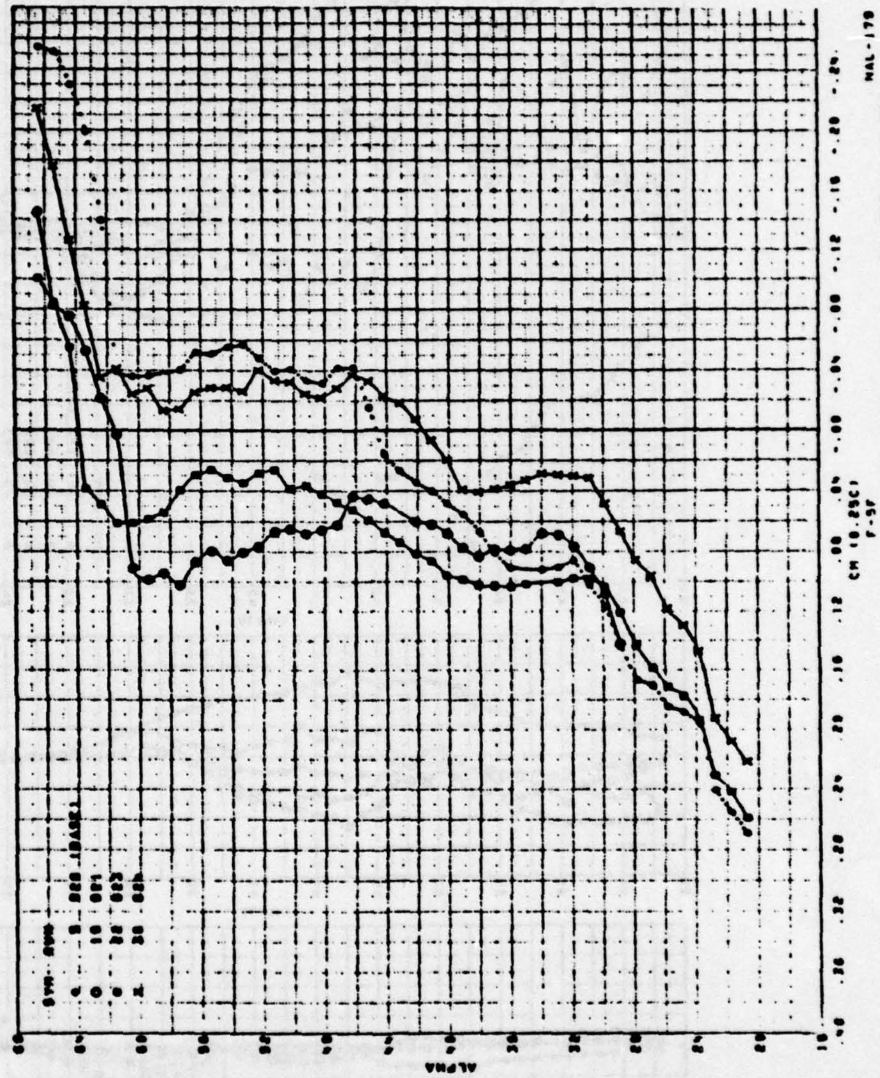


Figure 307. Effect of Nose Radius

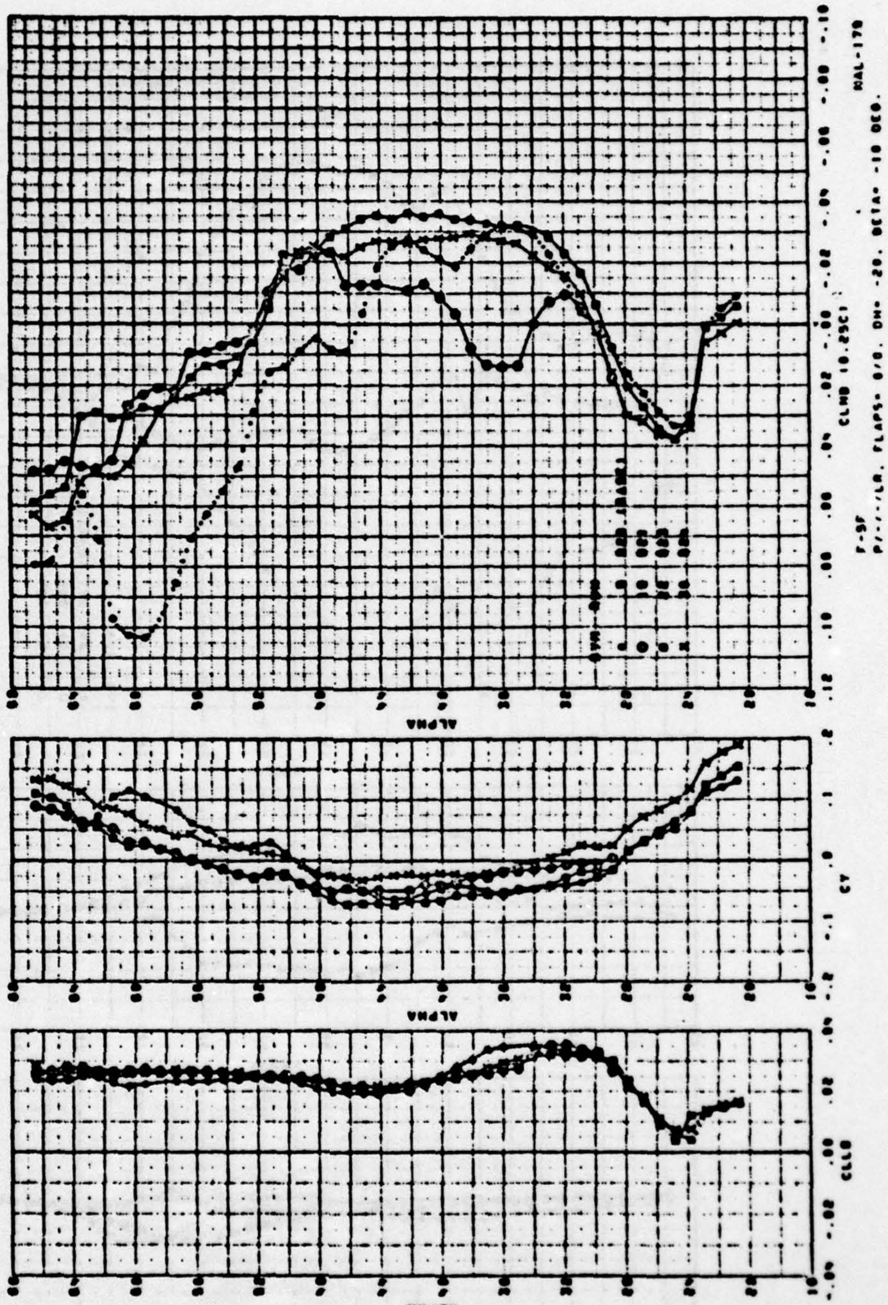


Figure 308. Effect of Nose Radius

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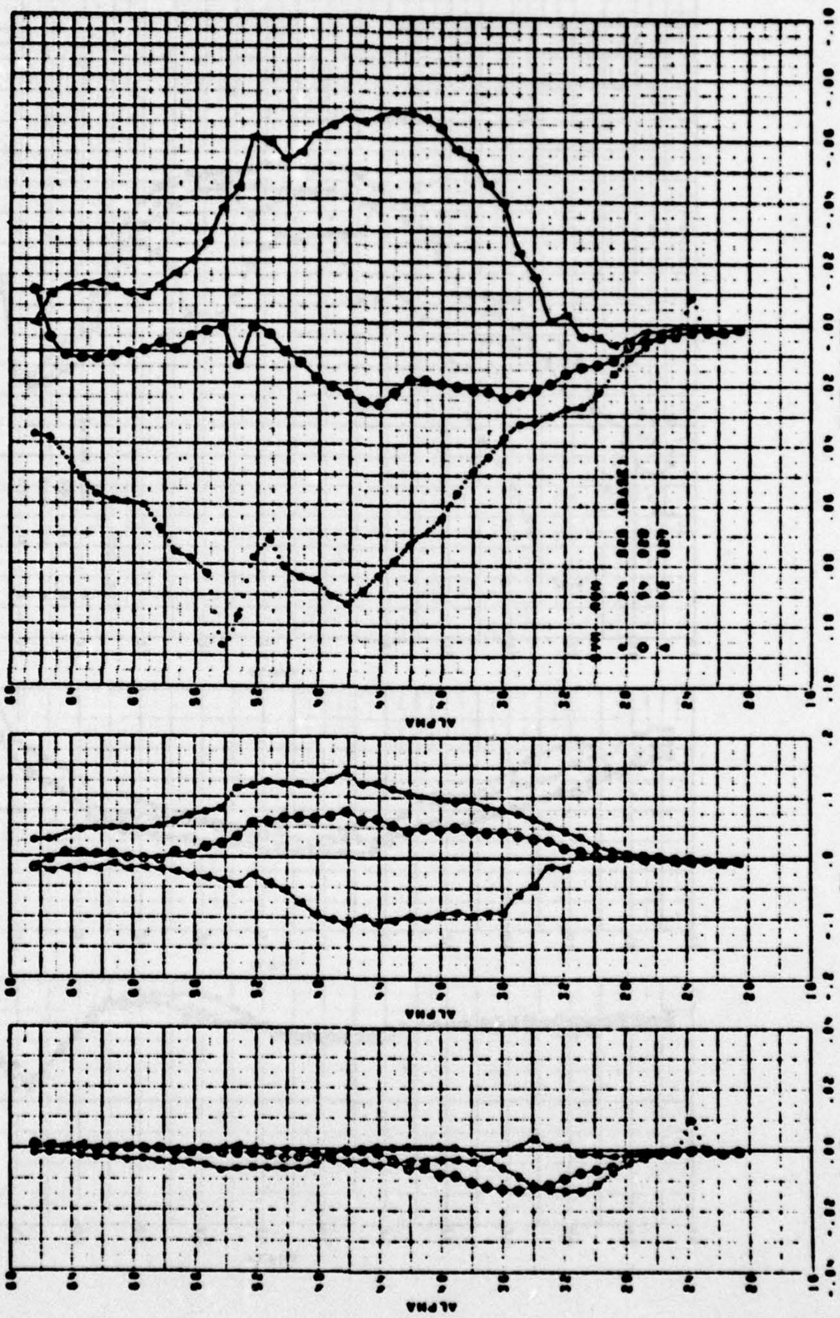


Figure 309. Effect of Nose Angle

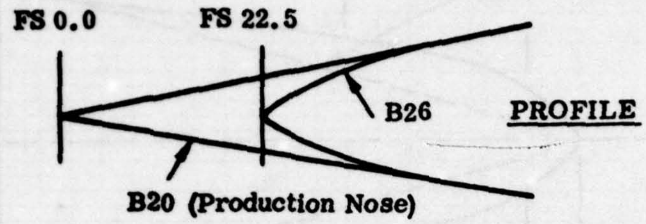


Figure 310. Nose Bluntness (B20, B26)

Full Scale Dimensions

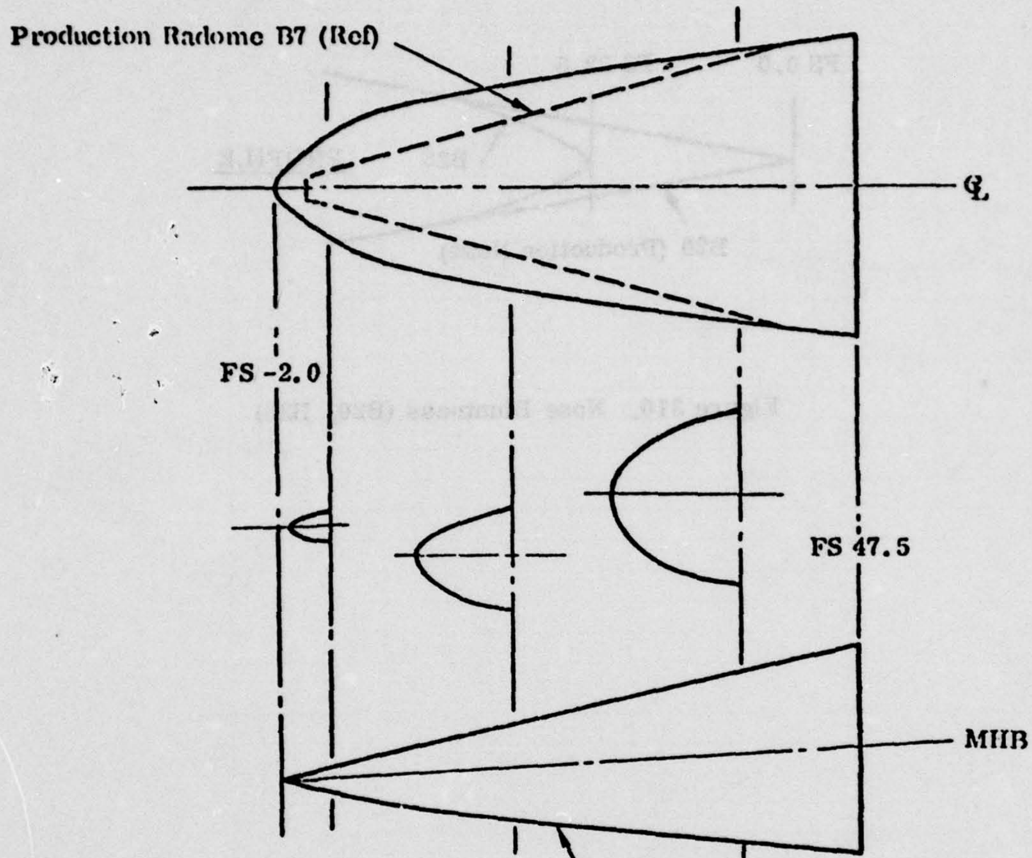


Figure 311. Nose Broadness (B7, B29)

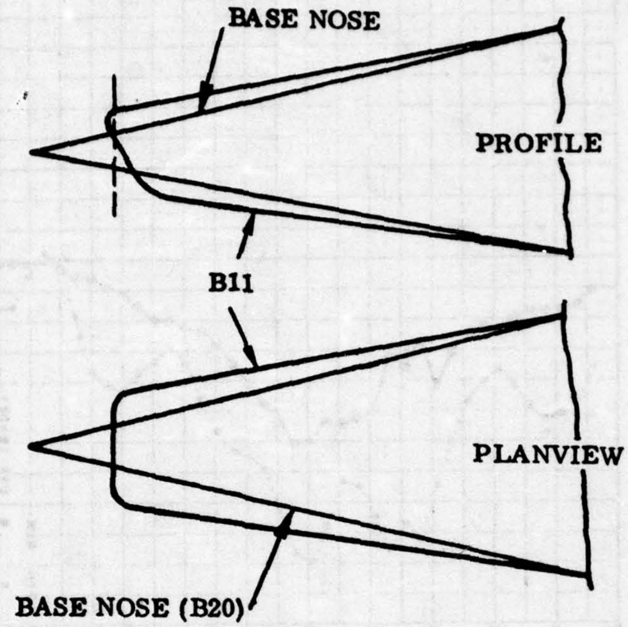


Figure 312. Nose Bluntness (B20, B11)

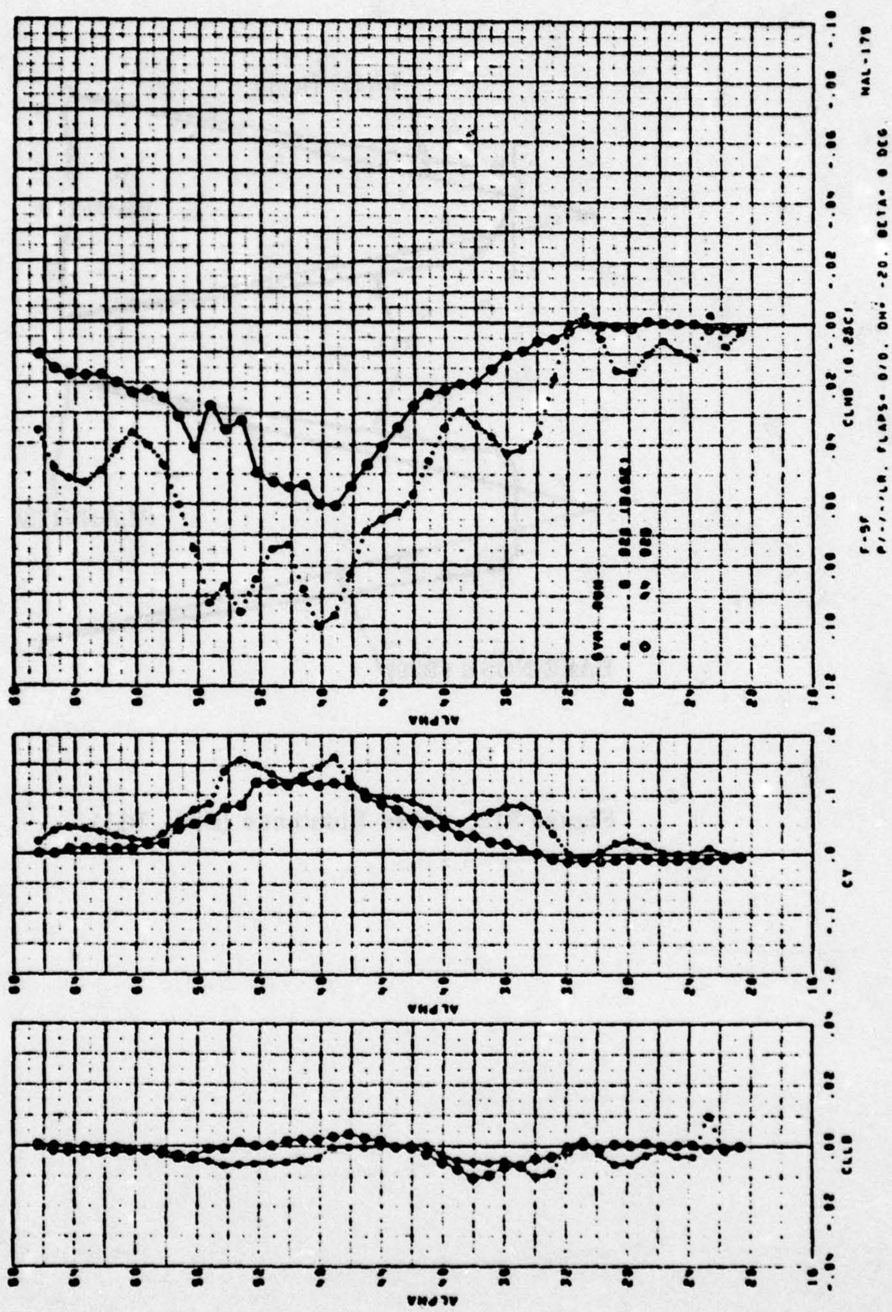


Figure 313. Effect of Nose Bluntness

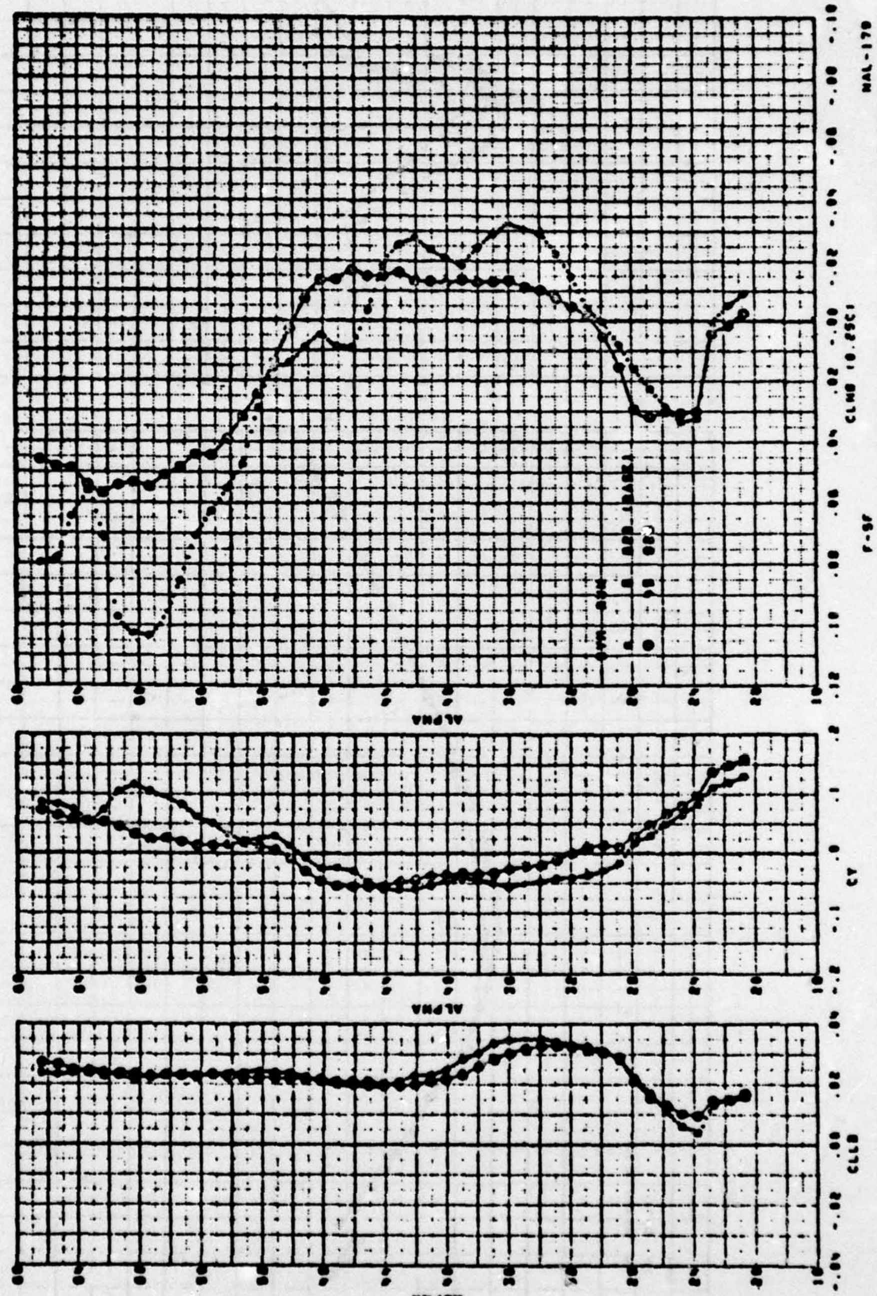


Figure 314. Effect of Nose Bluntness

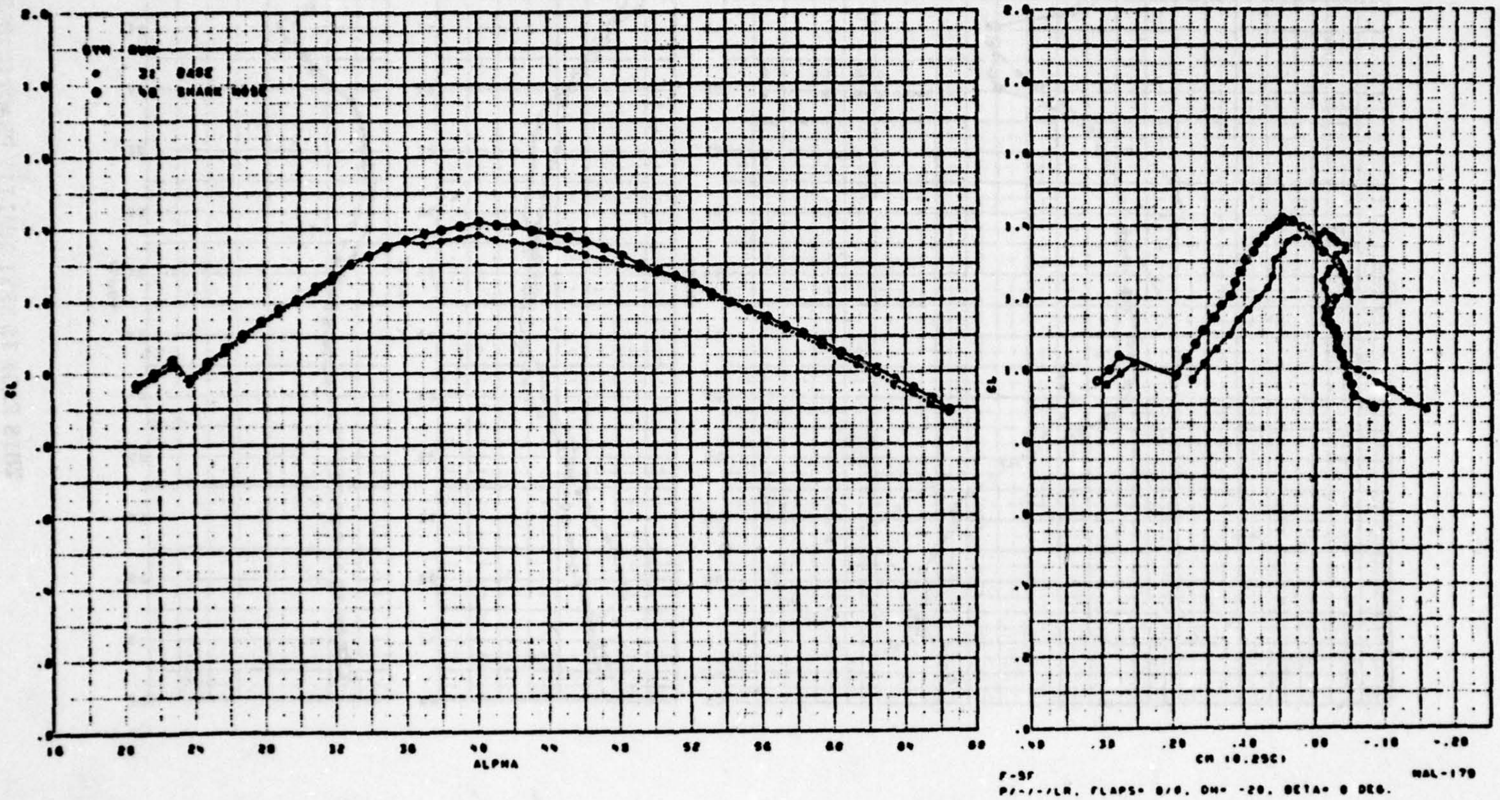


Figure 315. Effect of Shark Nose

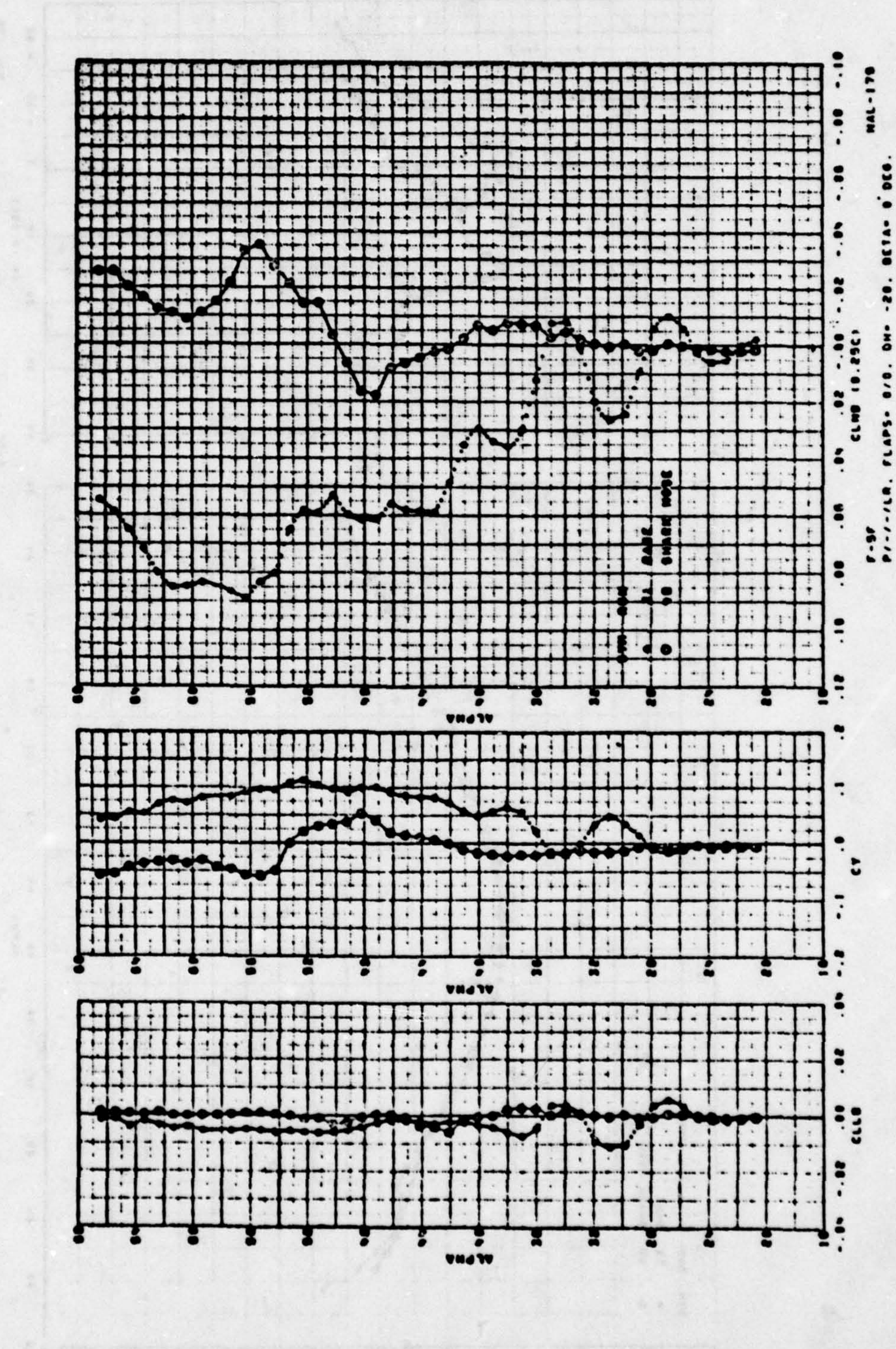


Figure 316. Effect of Shark Nose

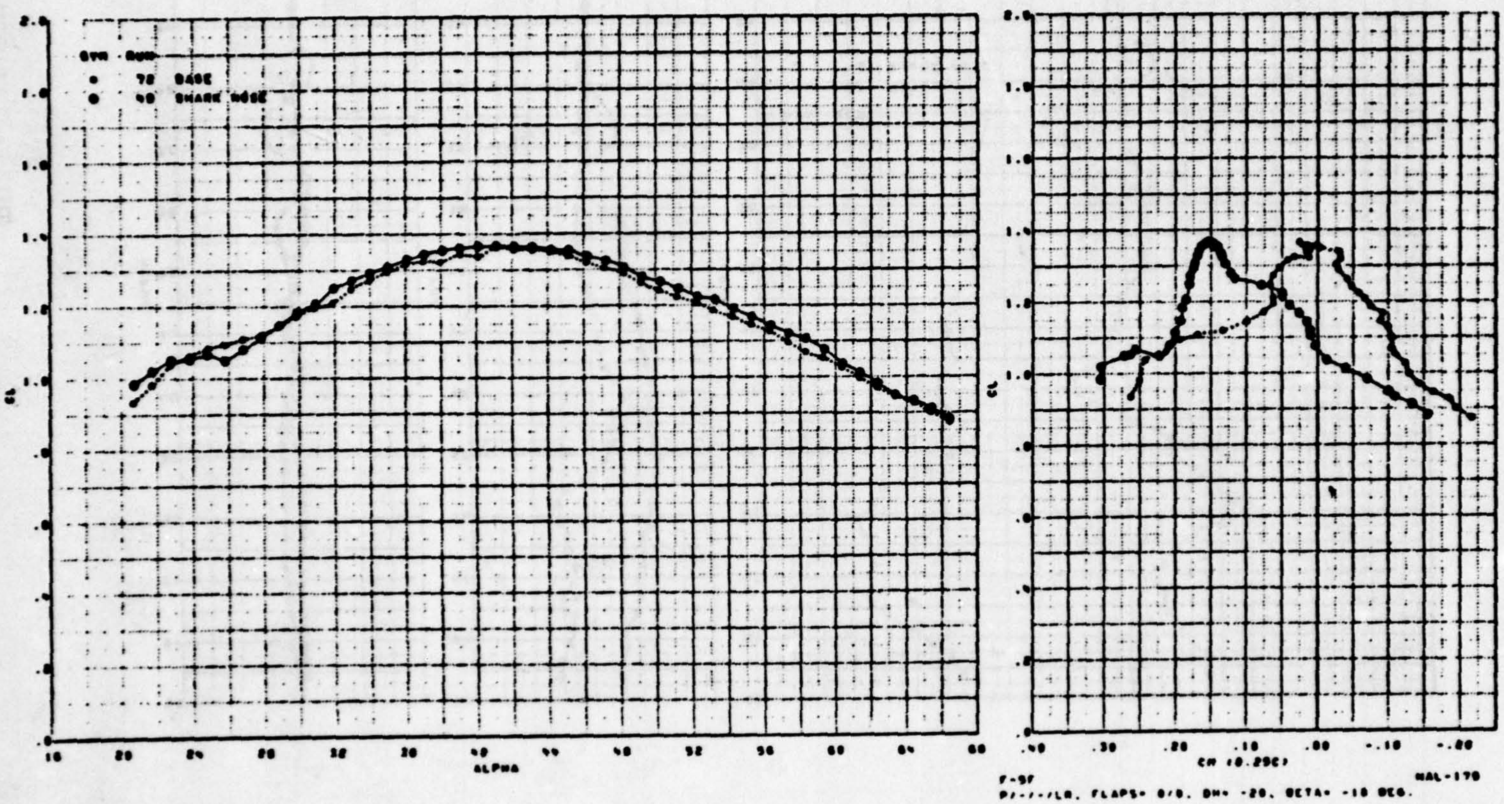


Figure 317. Effect of Shark Nose

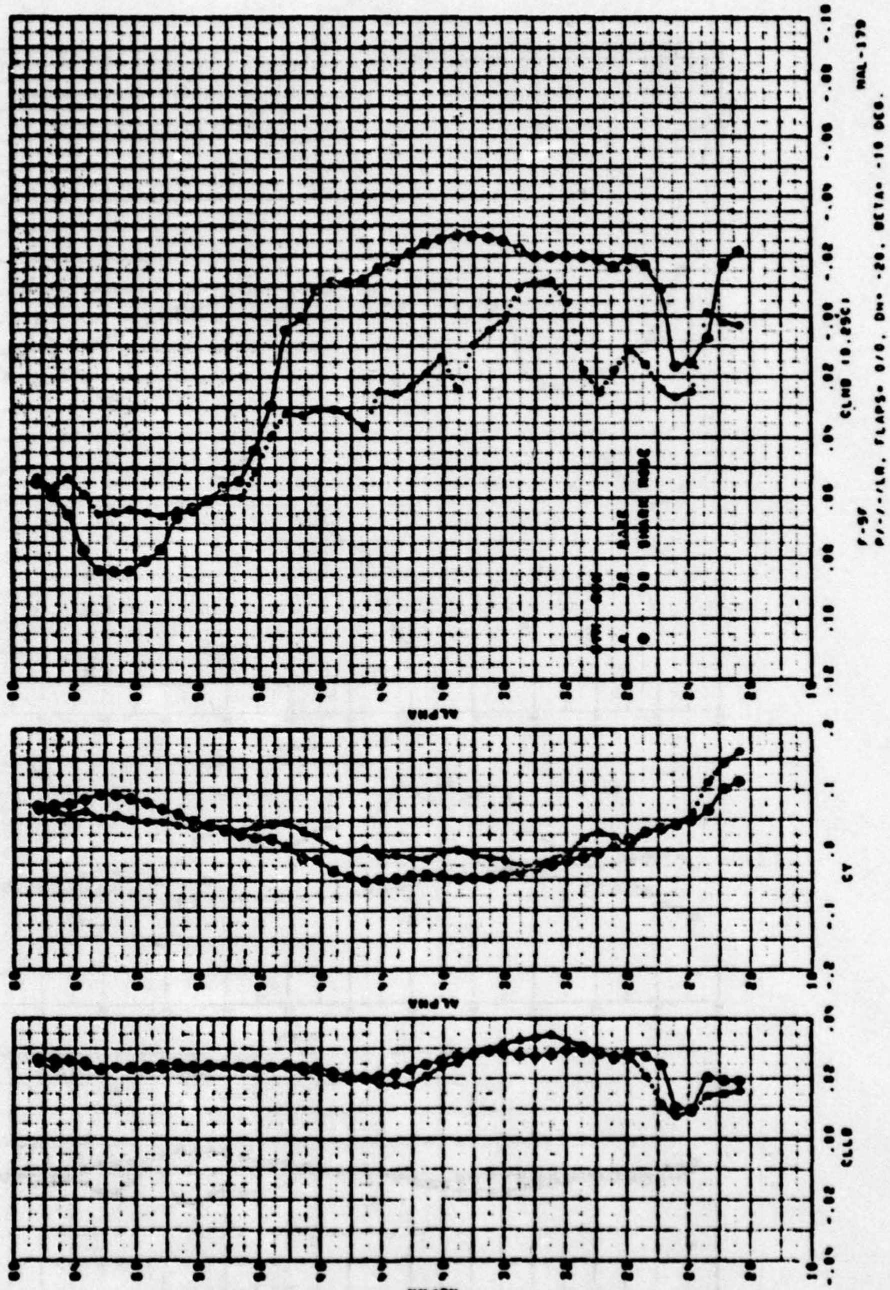


Figure 318. Effect of Shark Nose

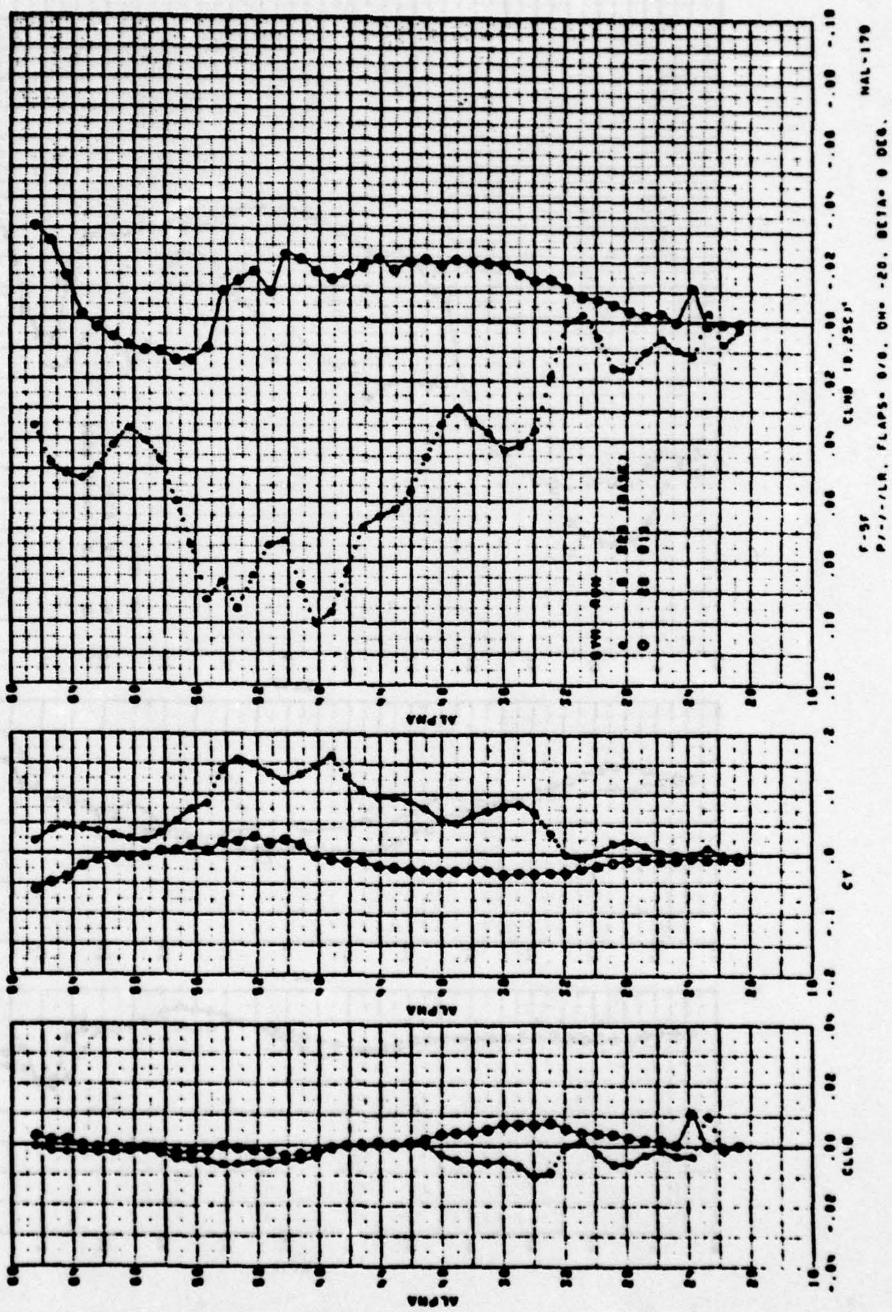


Figure 319. Effect of Nose Bluntness

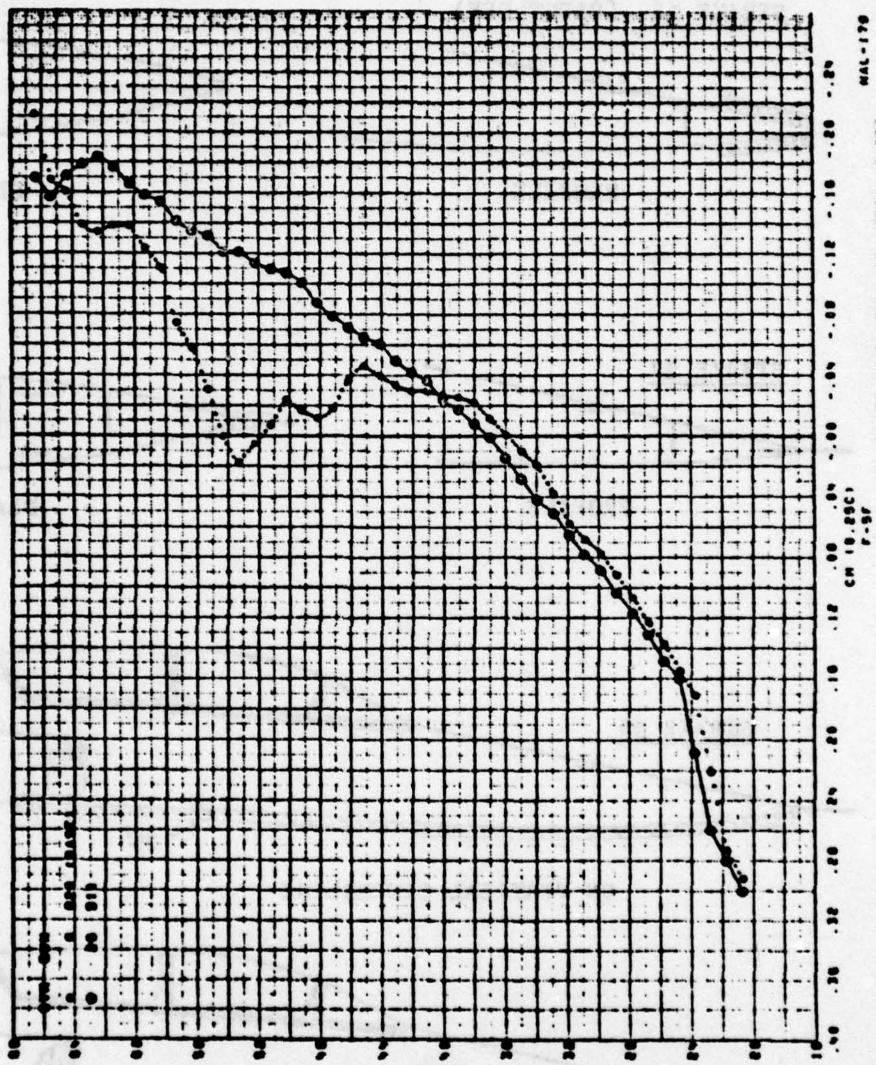


Figure 320. Effect of Nose Bluntness

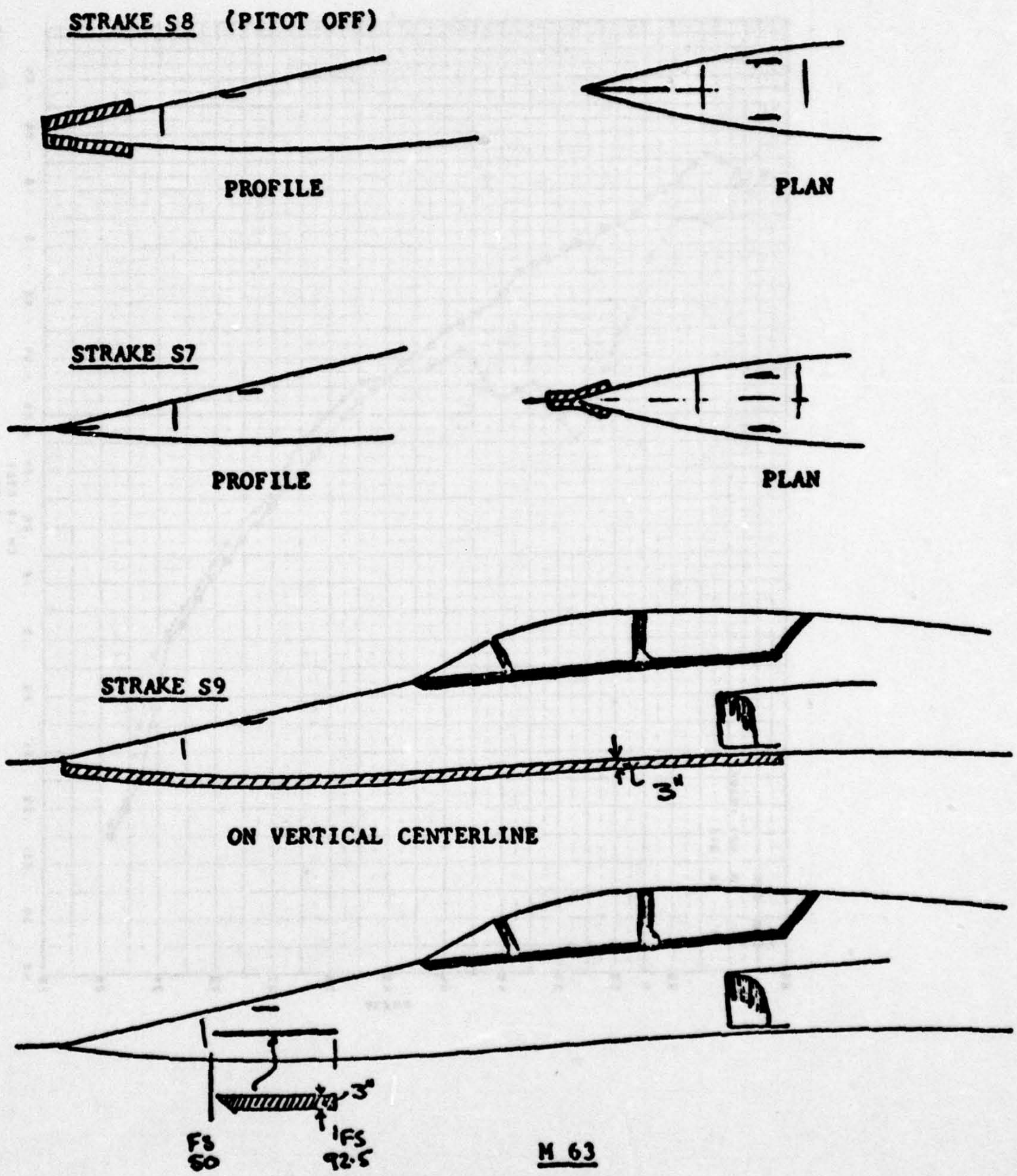
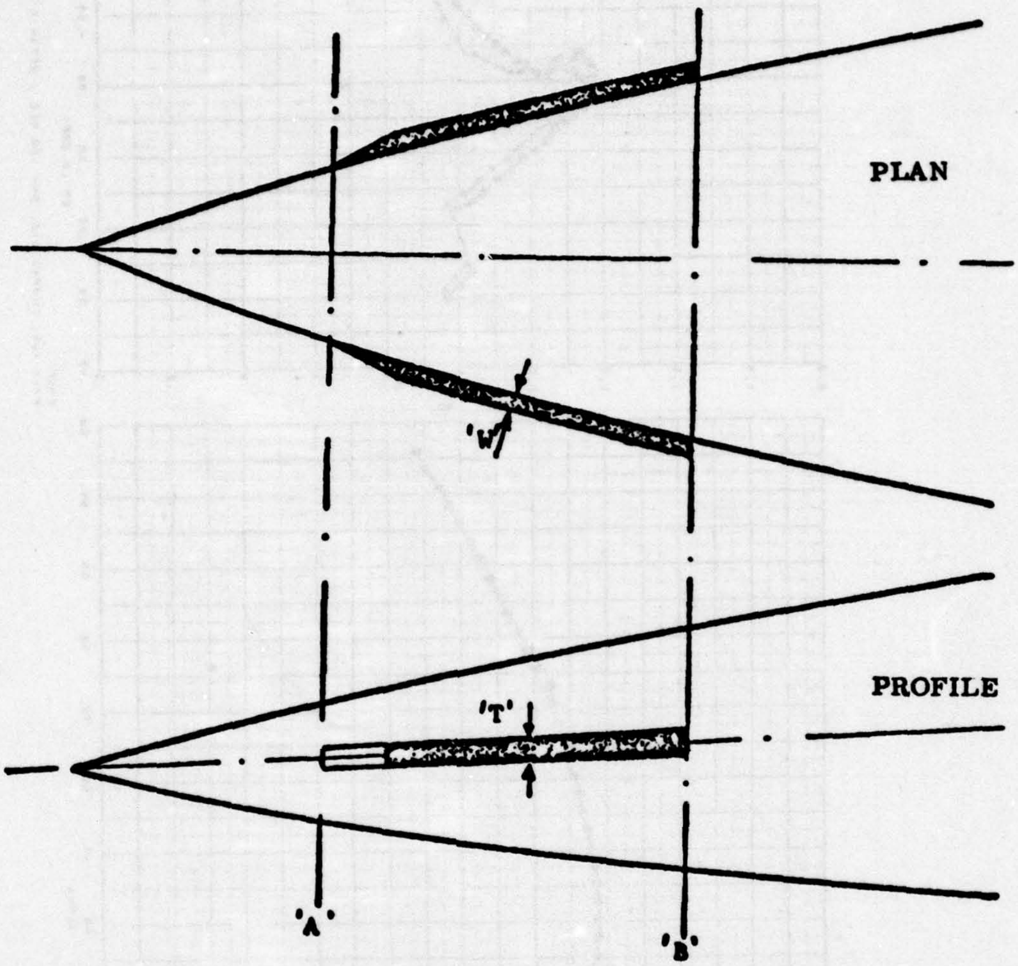


Figure 321. Miscellaneous Strakes



STRAKE	F.S. 'A'	F.S. 'B'	'W'	'T'	LOCN.
S10	10	47.5	1.25	1.25	M.H.B.
S11	10	47.5	"	"	
S12	29	47.5	"	"	M.H.B
S13	10	29	"	"	"
S14	10	29	"	"	" (Faired)

Figure 322. Nose Strakes

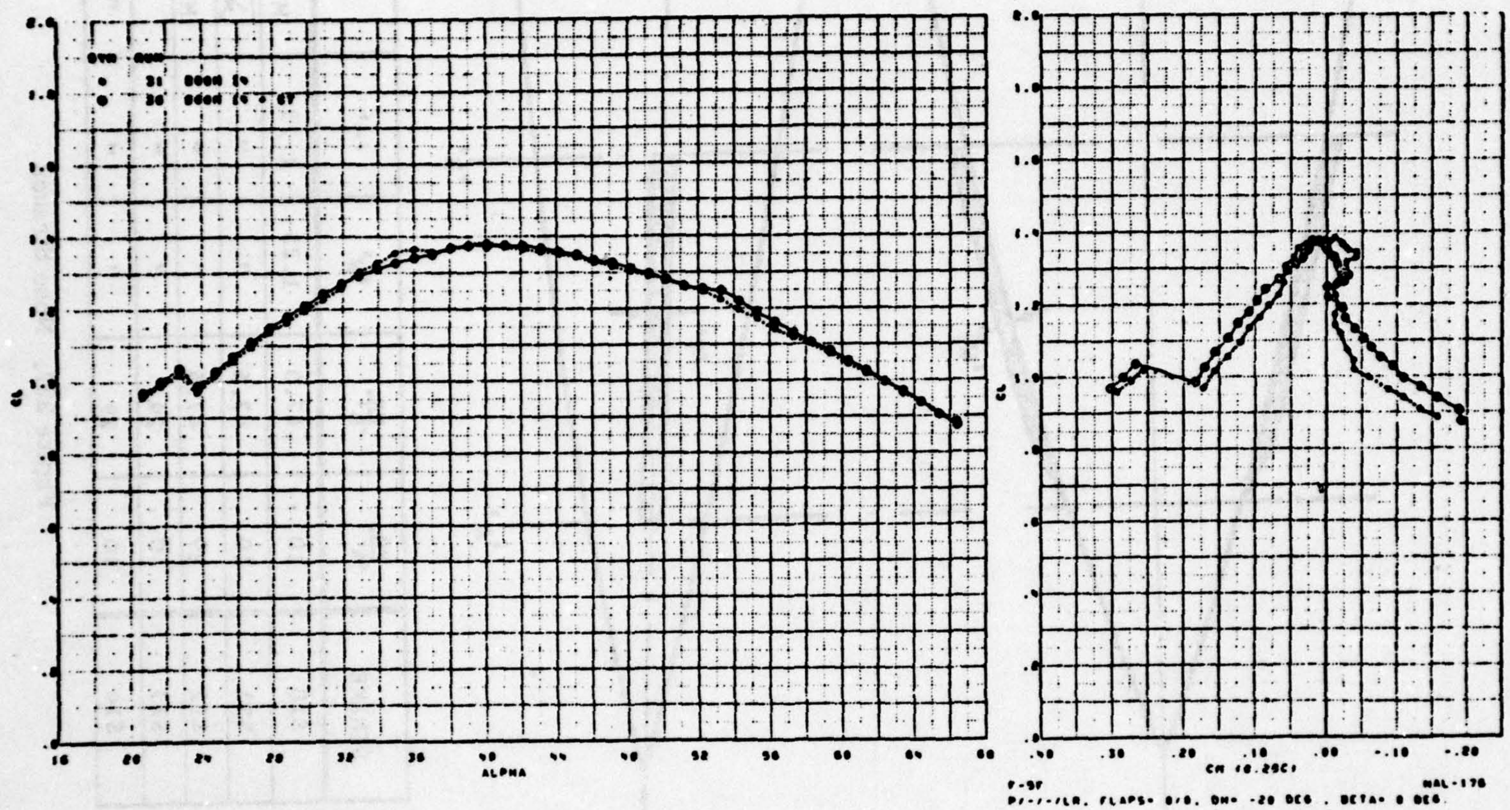


Figure 323. Effect of Pitot Strake S7

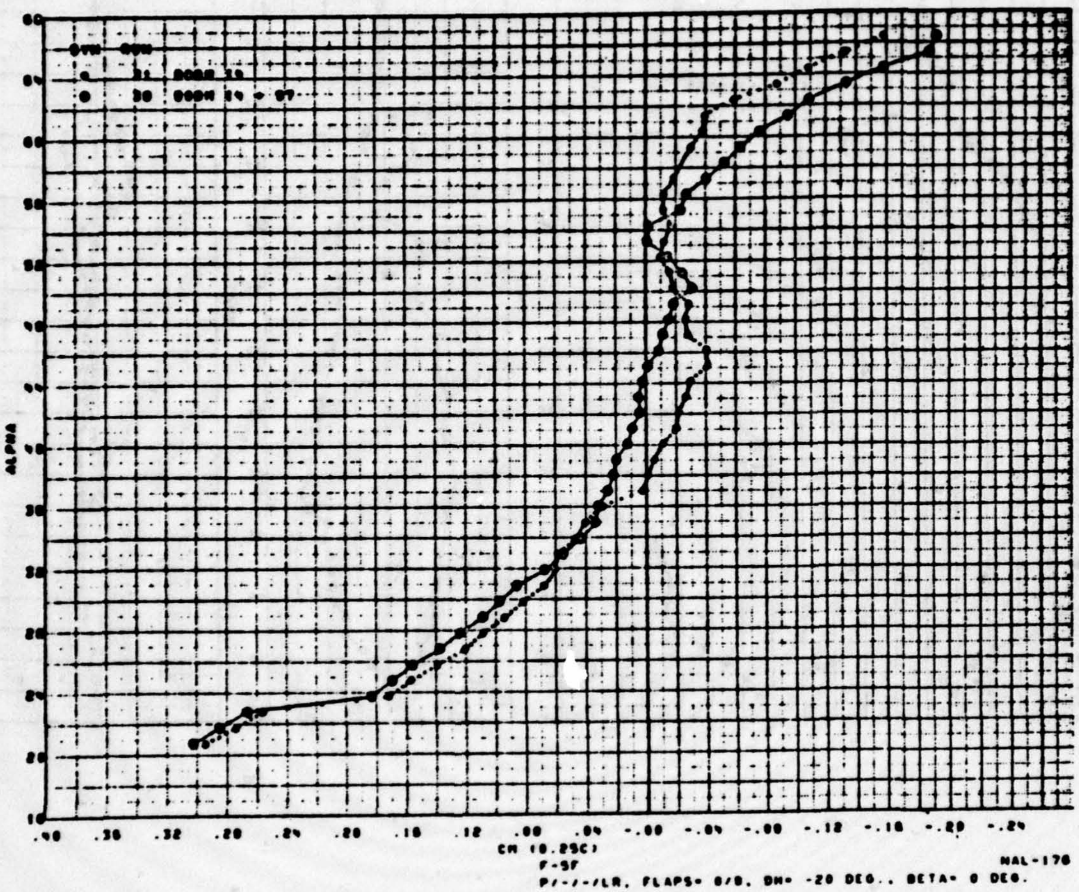


Figure 324. Effect of Pitot Strake S7

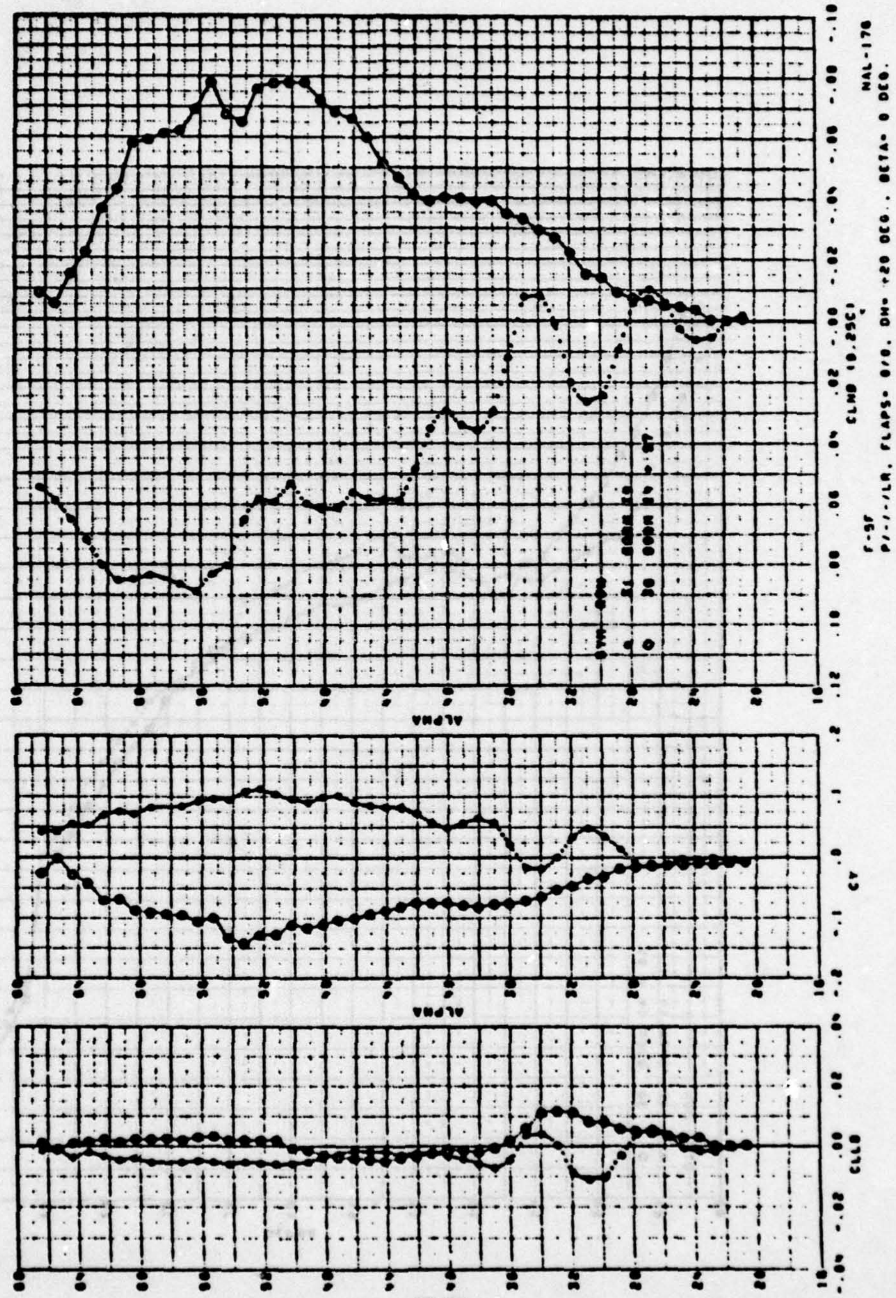


Figure 325. Effect of Pitot Strake S7

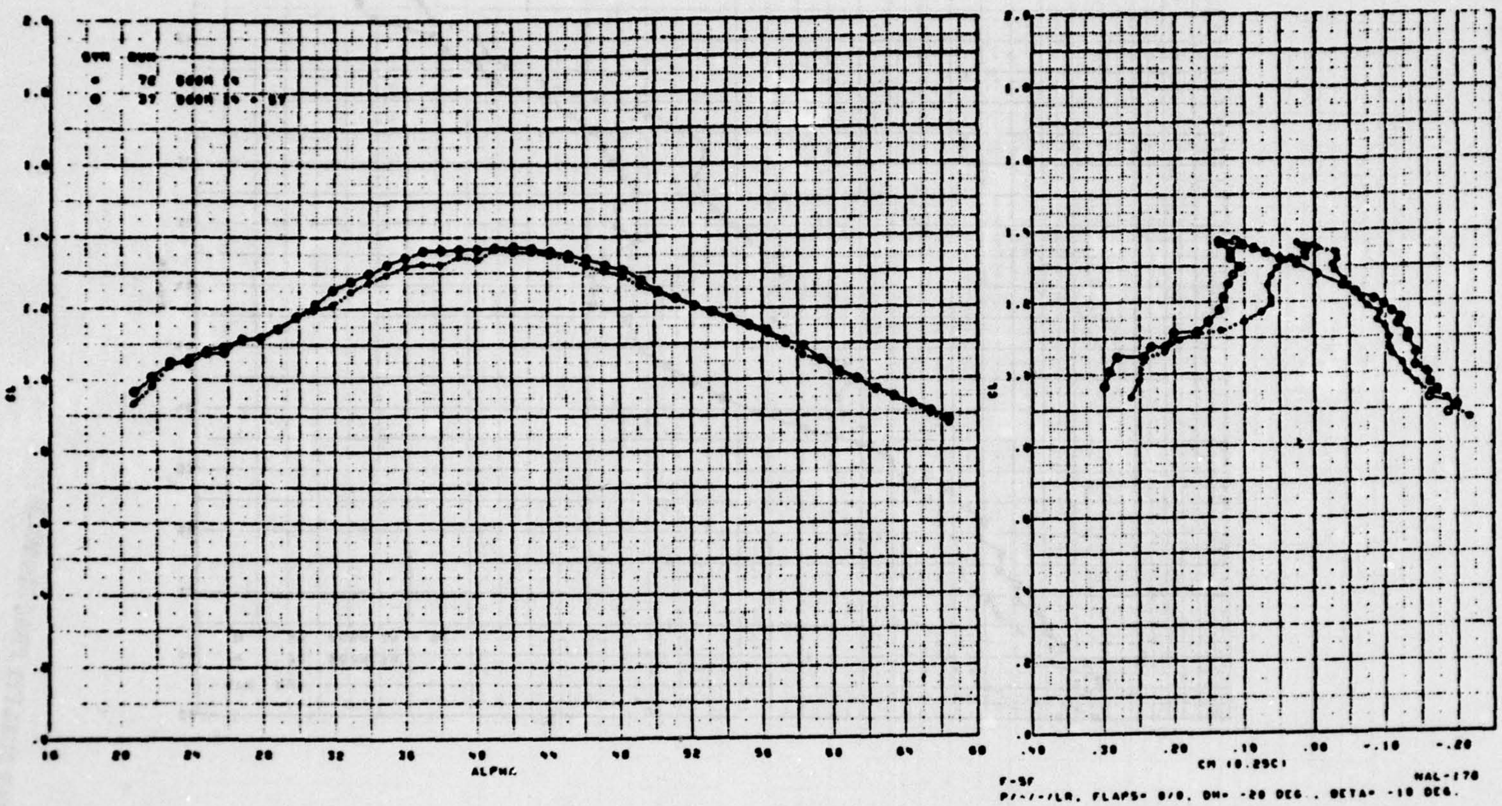


Figure 326. Effect of Pitot Strake S7

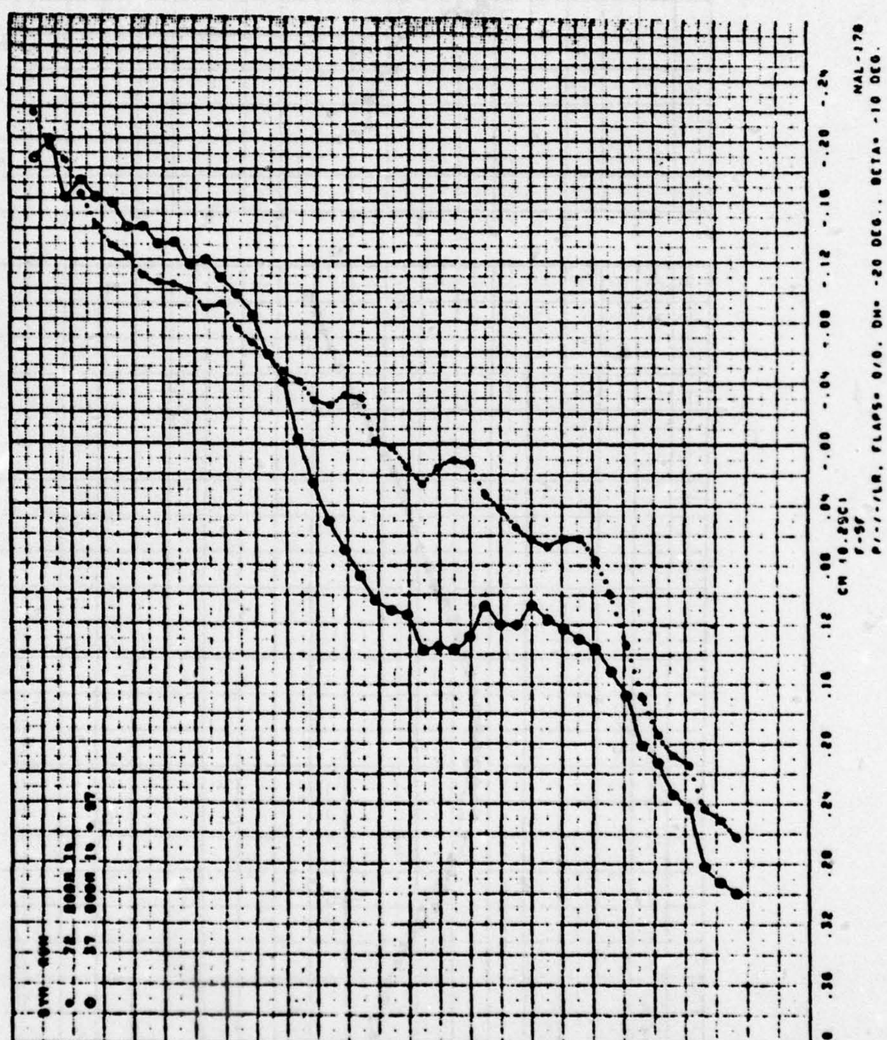


Figure 327. Effect of Pitot Strake S7

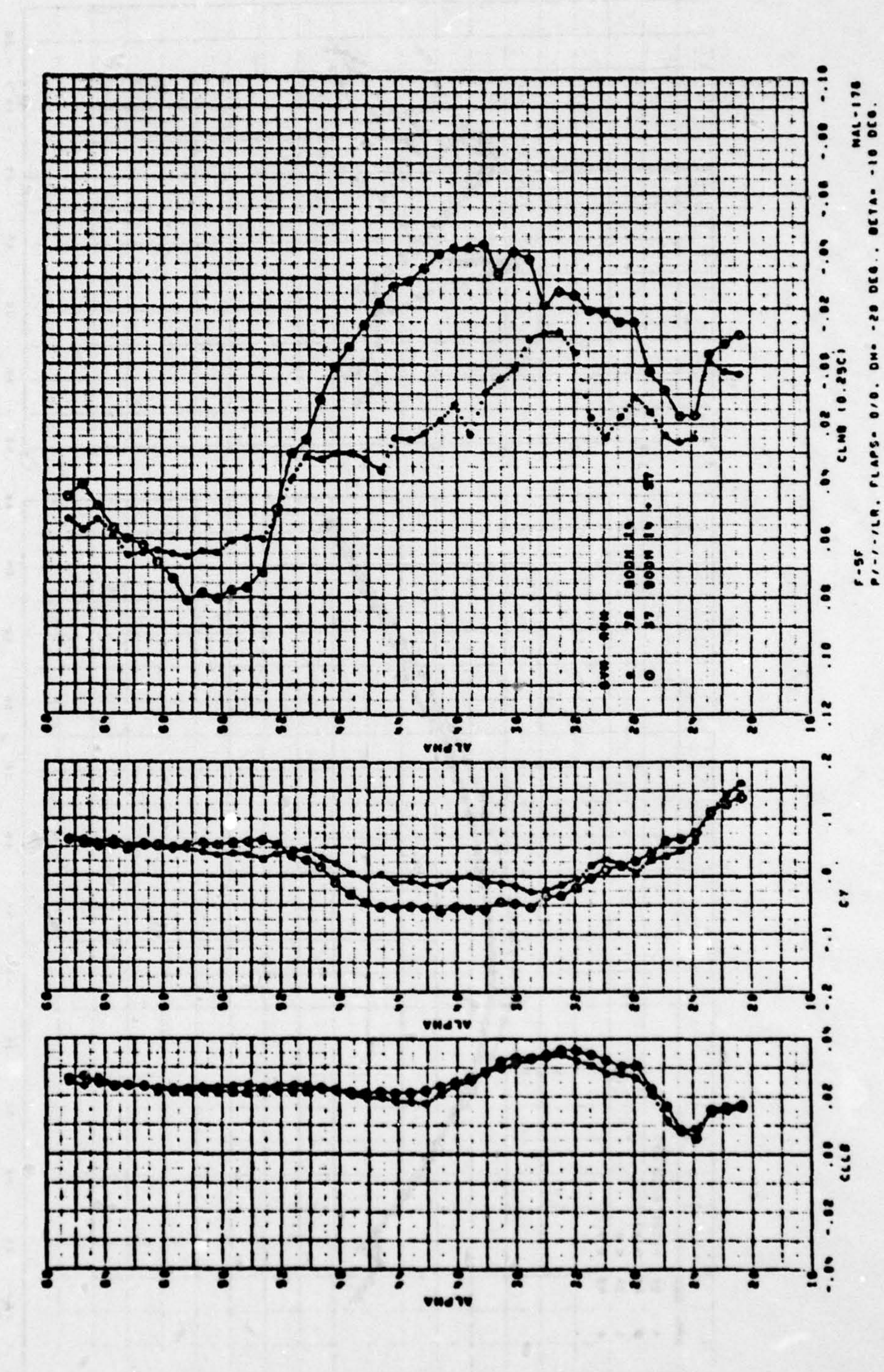


Figure 328. Effect of Pitot Strake S7

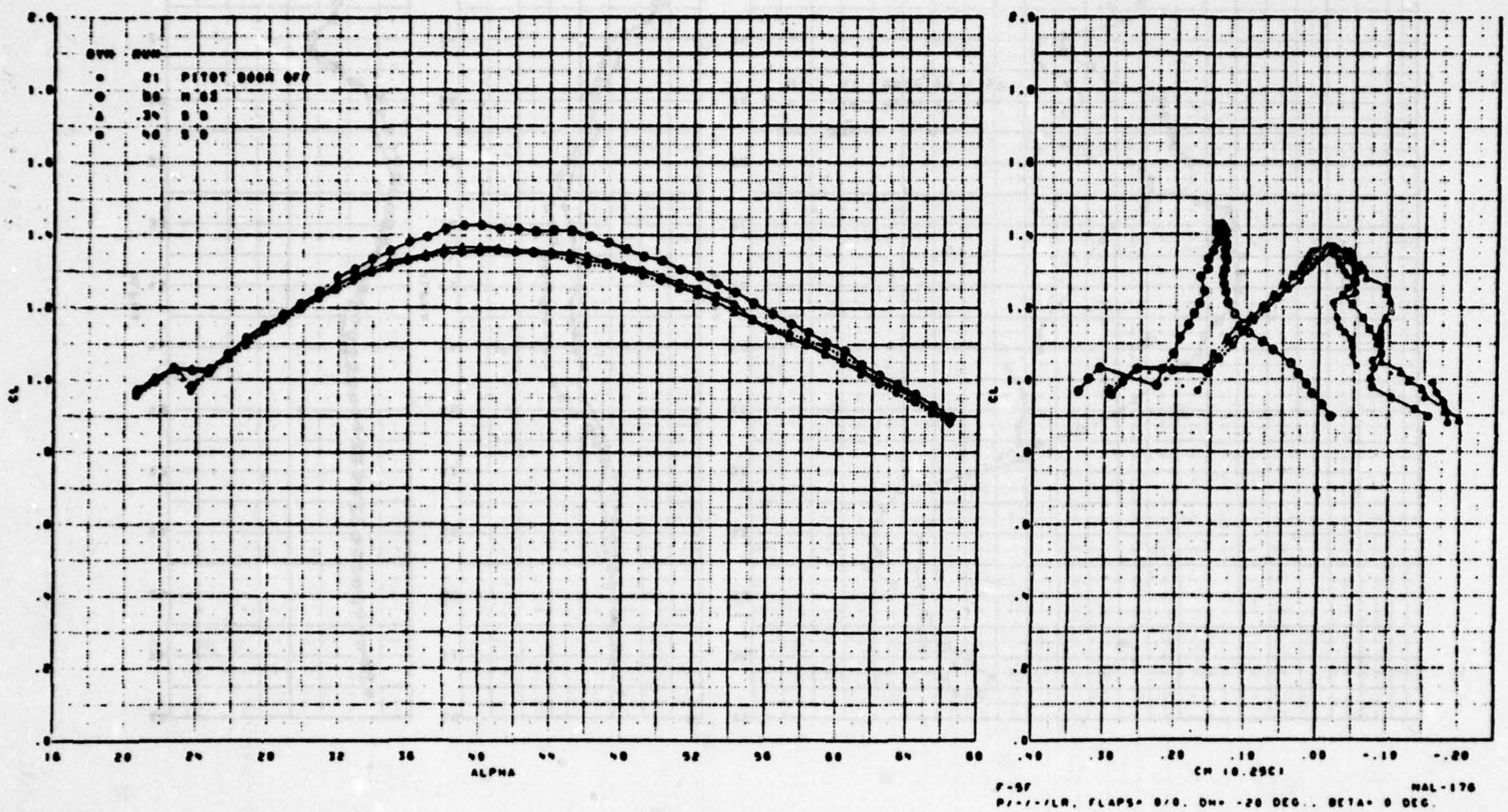


Figure 329. Effect of Vertical and Rearward Strakes S8, S9, m63

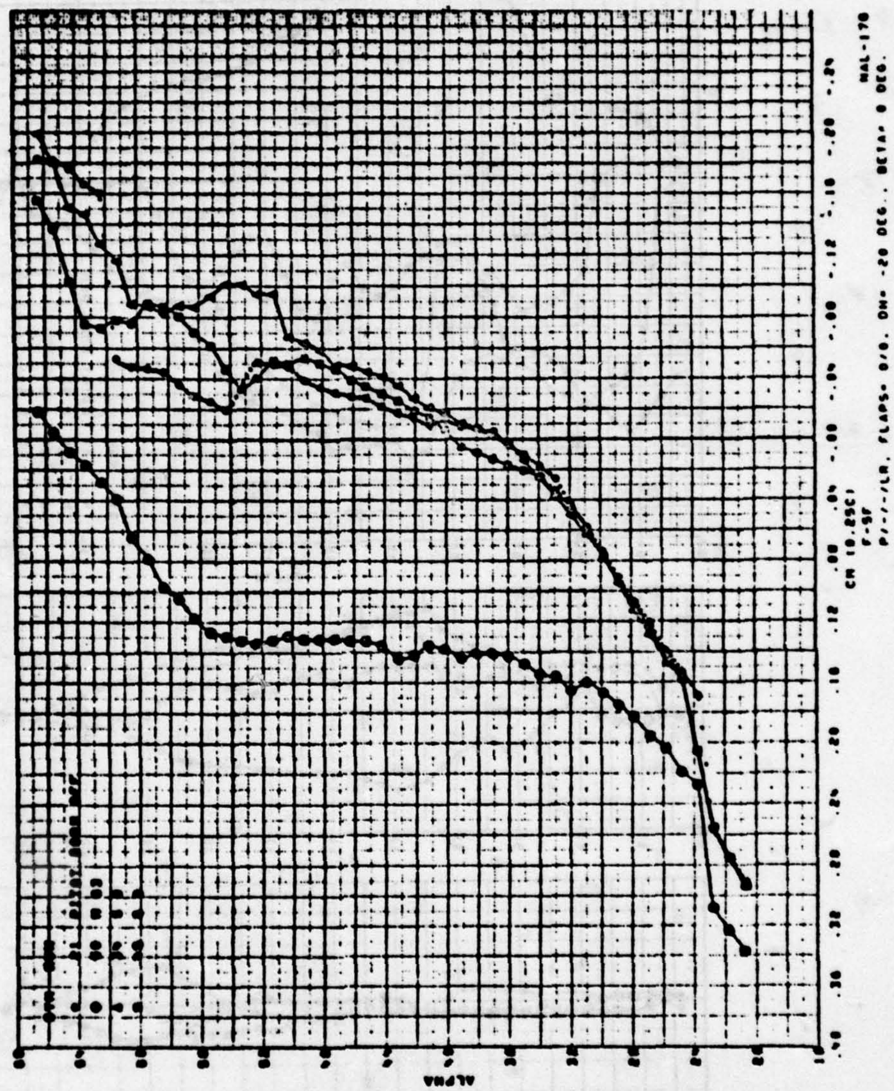


Figure 330. Effect of Vertical and Rearward Strakes S8, S9, m63

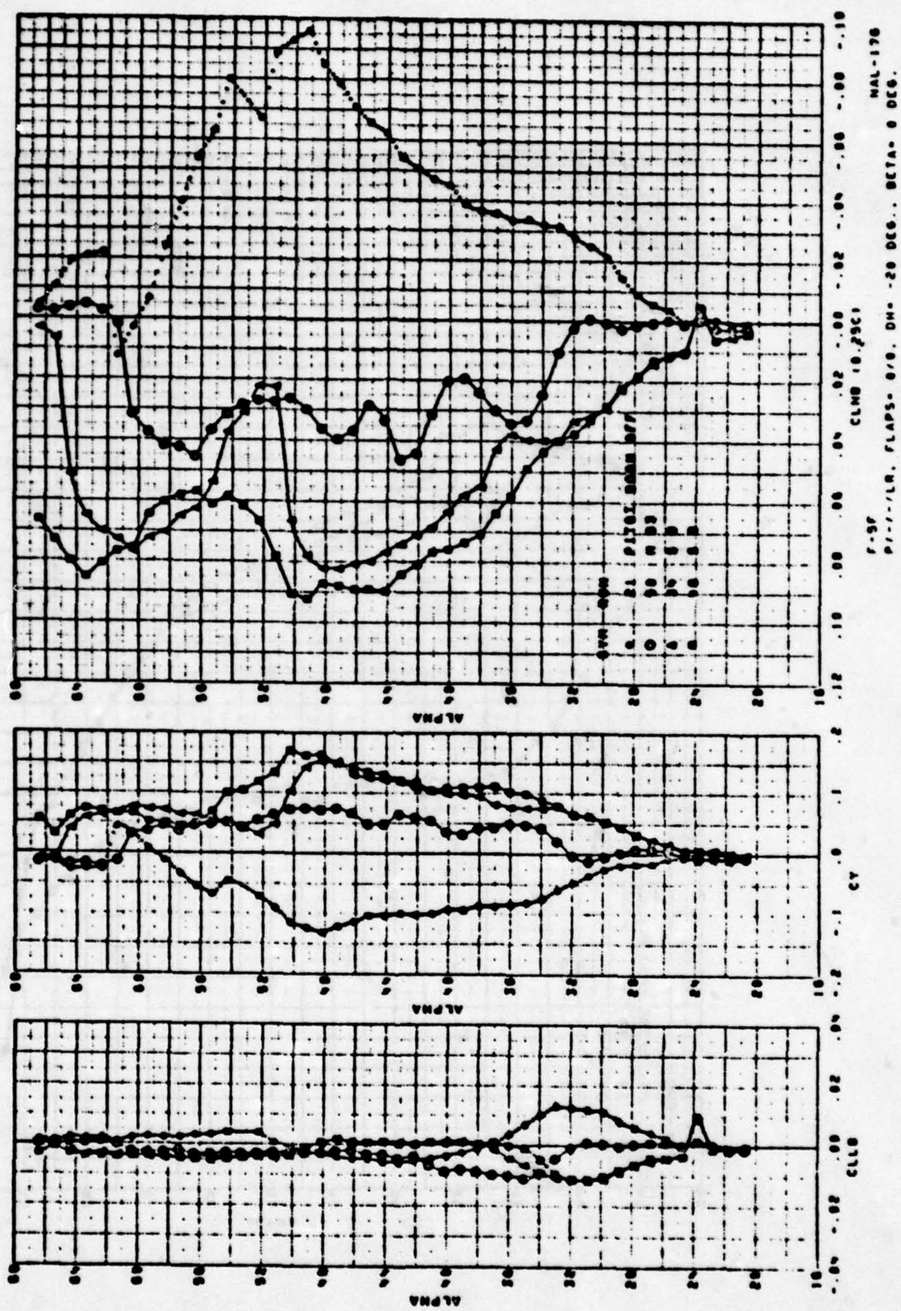


Figure 331. Effect of Vertical and Rearward Strakes S8, S9, m63

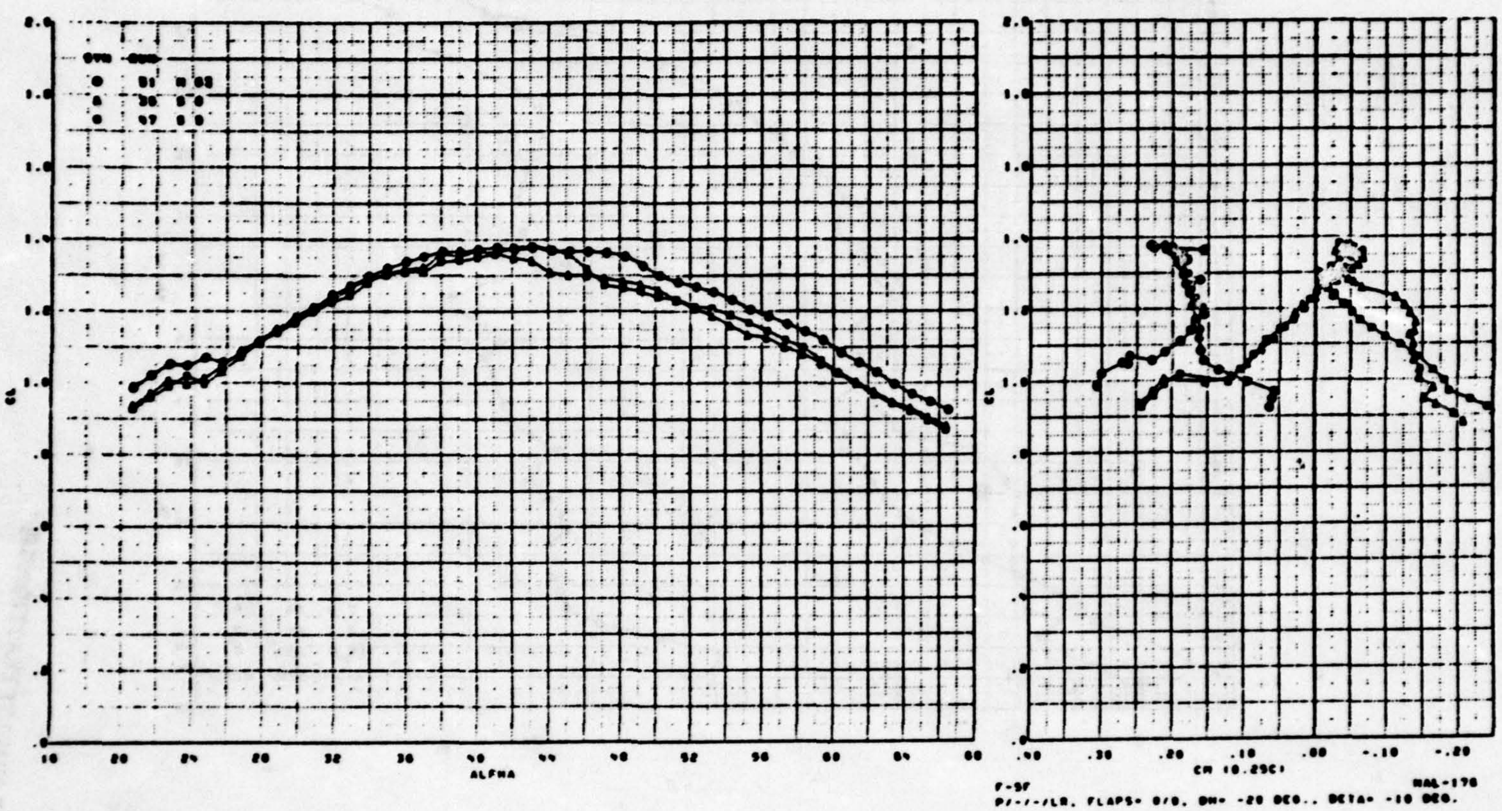


Figure 332. Effect of Vertical and Rearward Strakes S8, S9, m63

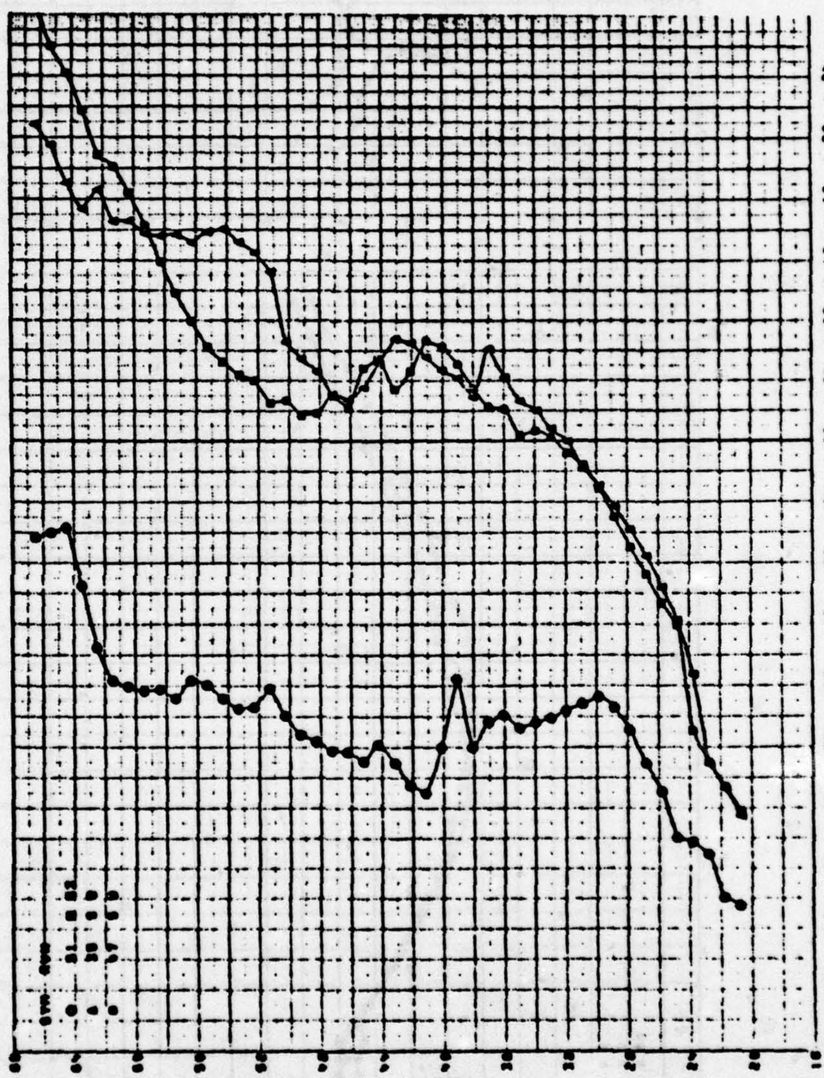


Figure 333. Effect of Vertical and Rearward Strakes S8, S9, m63

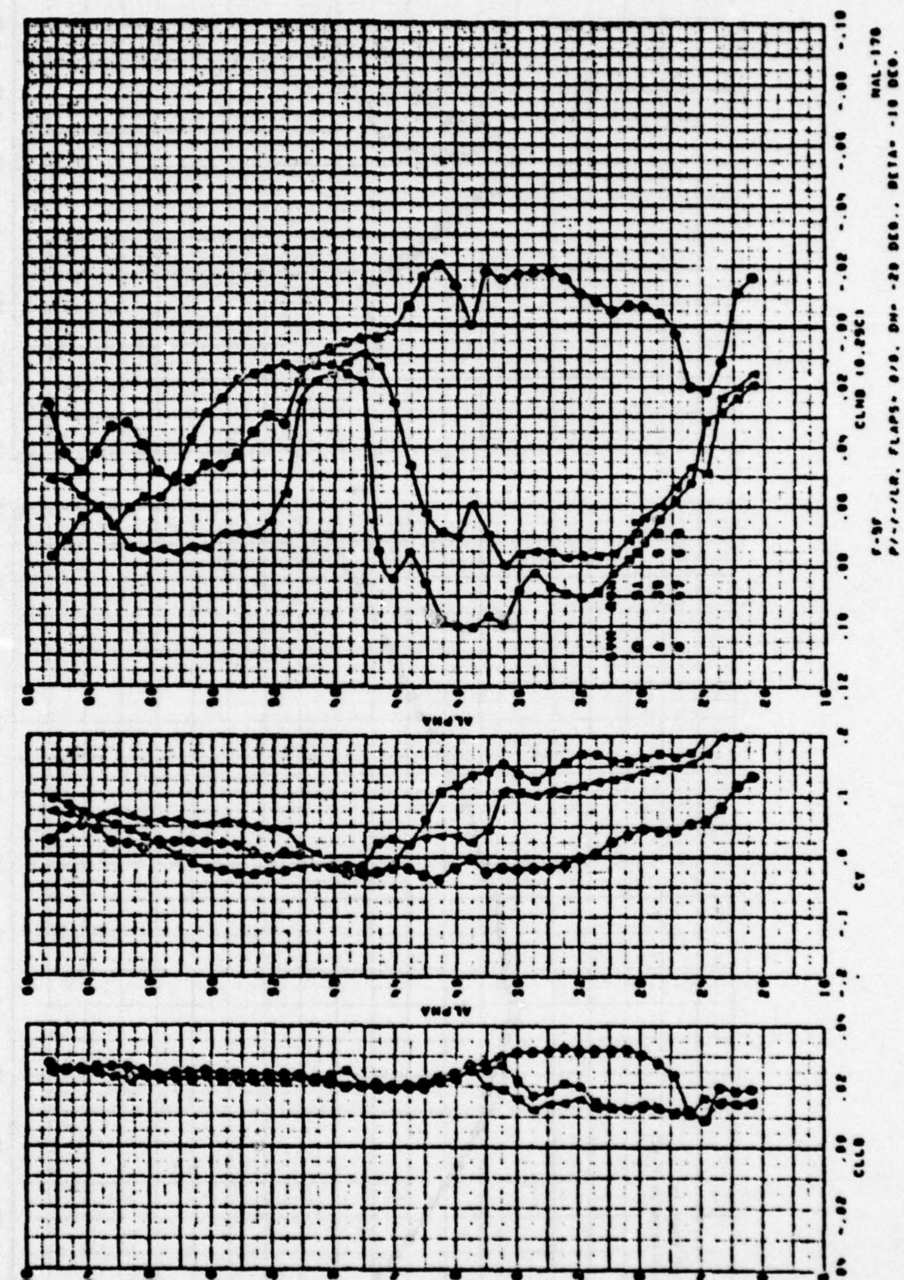


Figure 334. Effect of Vertical and Rearward Strakes S8, S9, m63

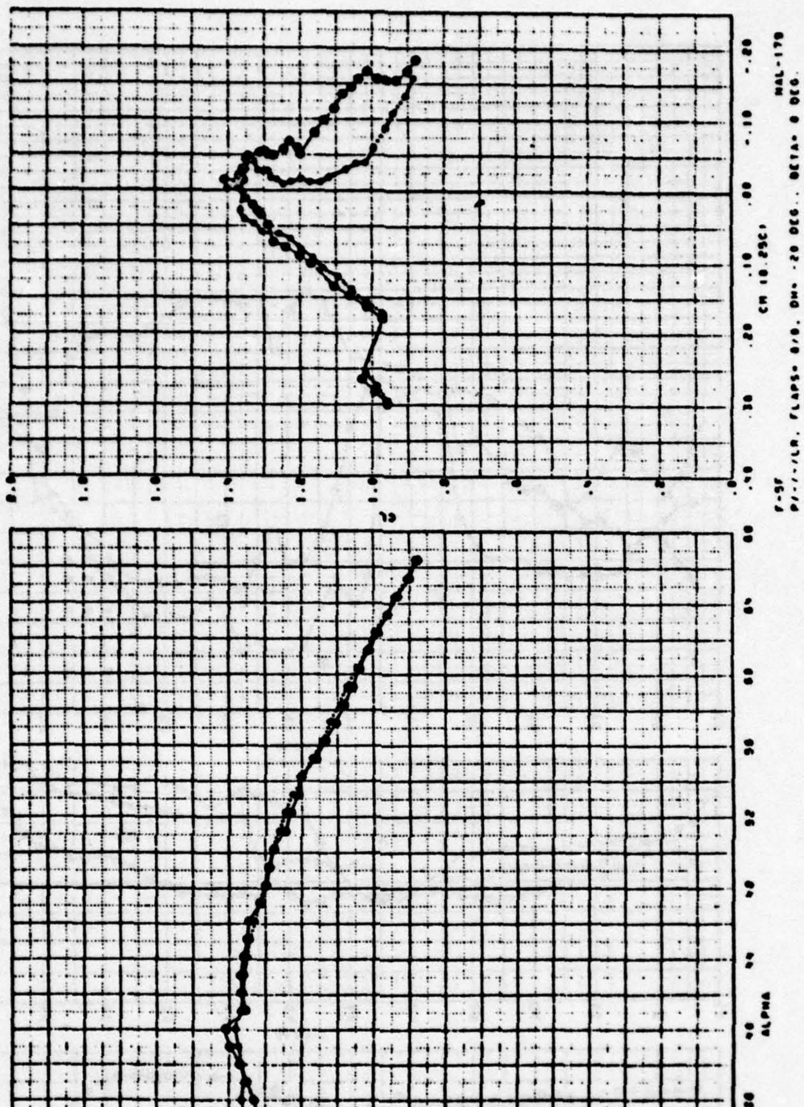


Figure 335. Effect of Lower Strakes S11

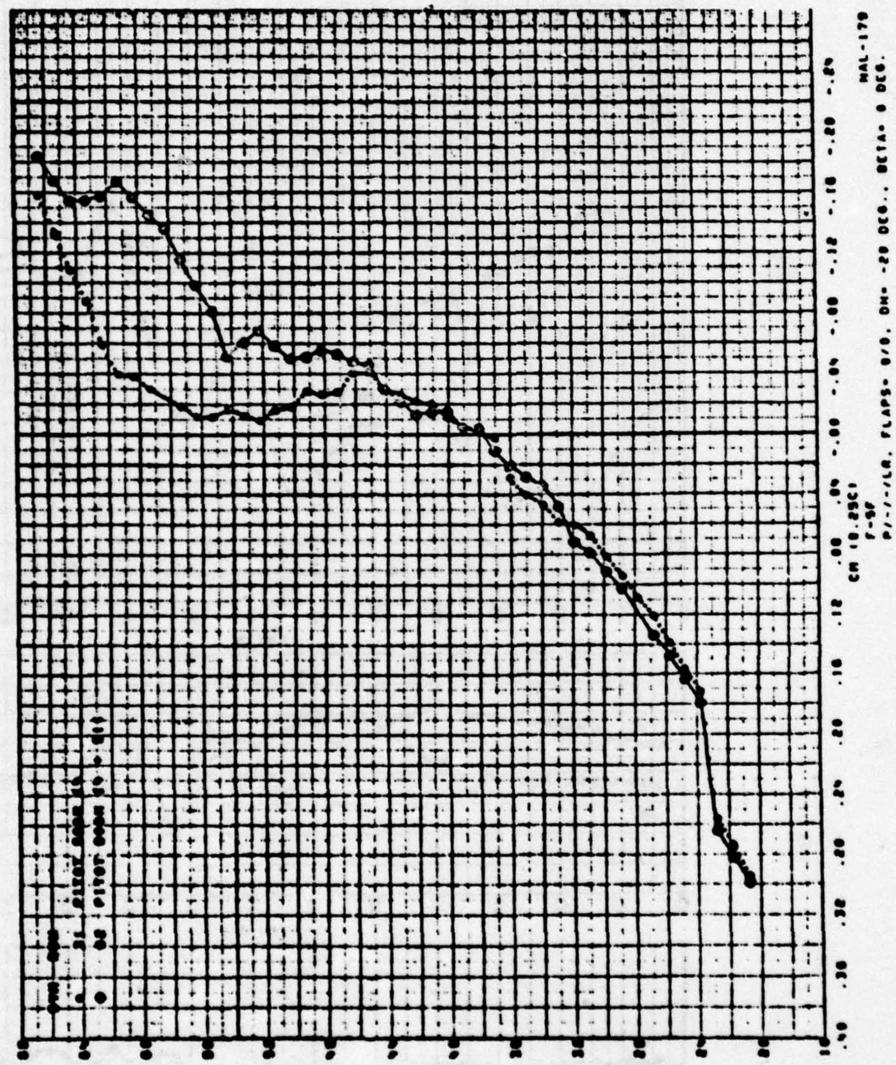


Figure 336. Effect of Lower Strakes S11

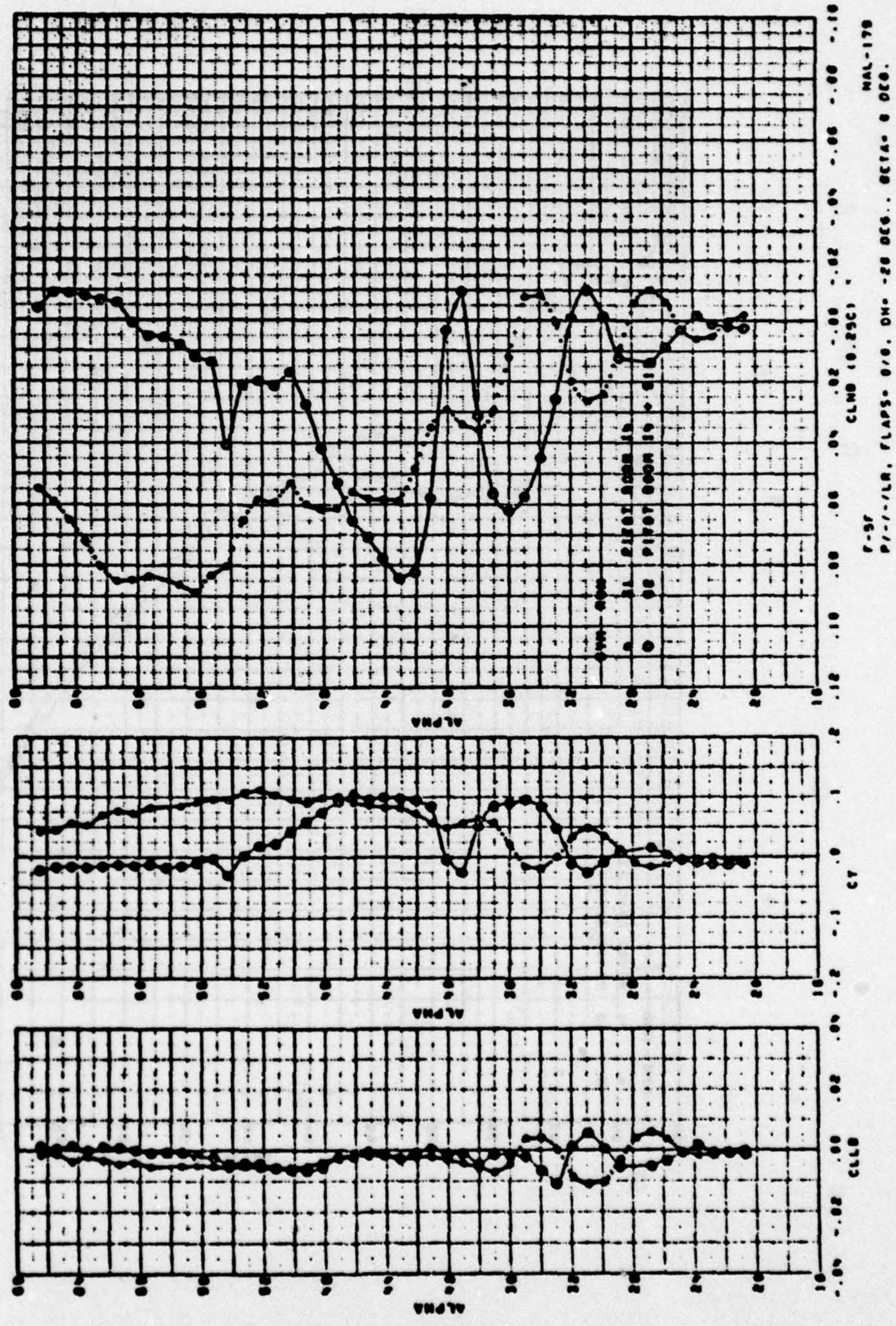


Figure 337. Effect of Lower Strakes S11

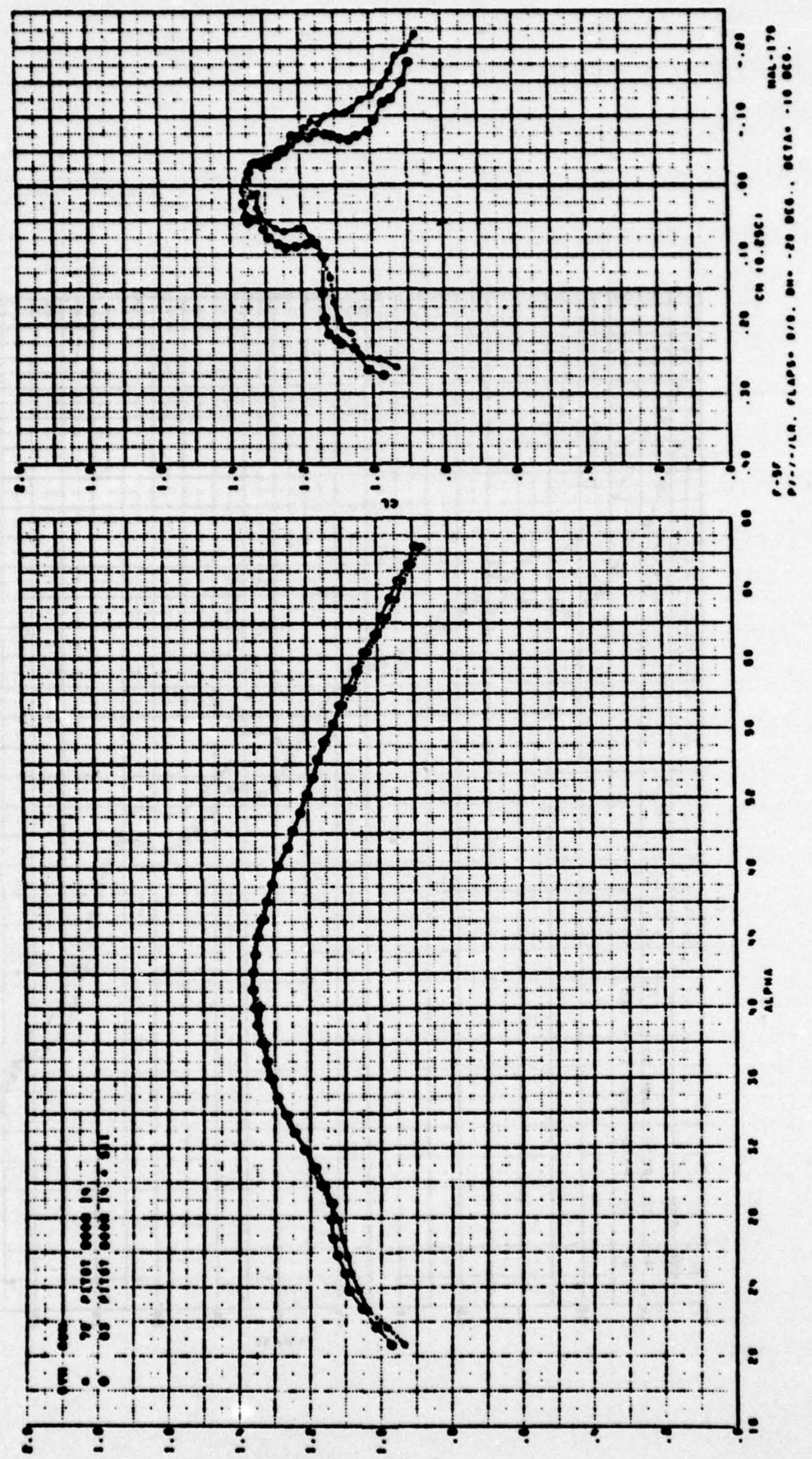


Figure 338. Effect of Lower Strakes S11

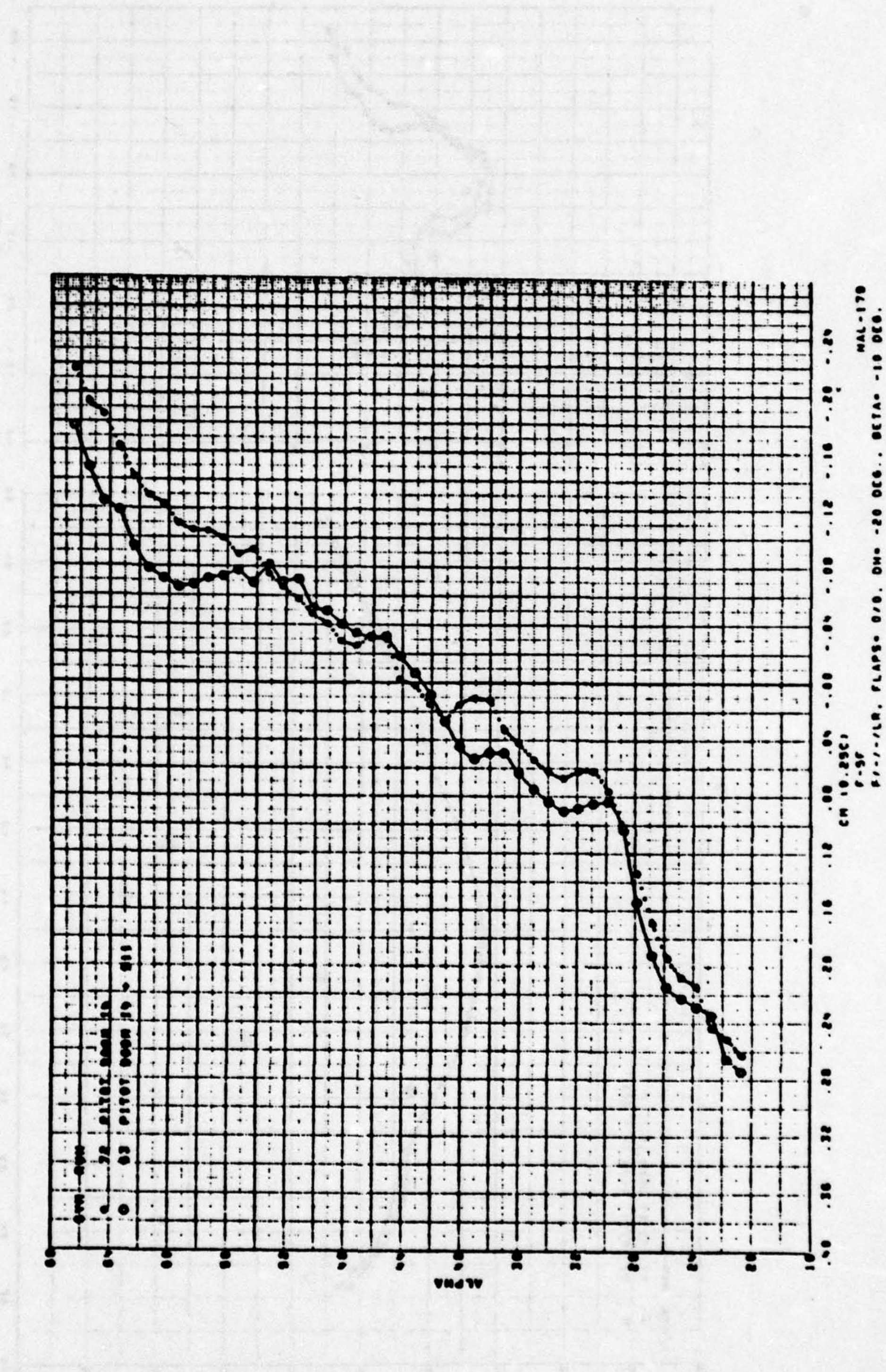


Figure 339. Effect of Lower Strakes S11

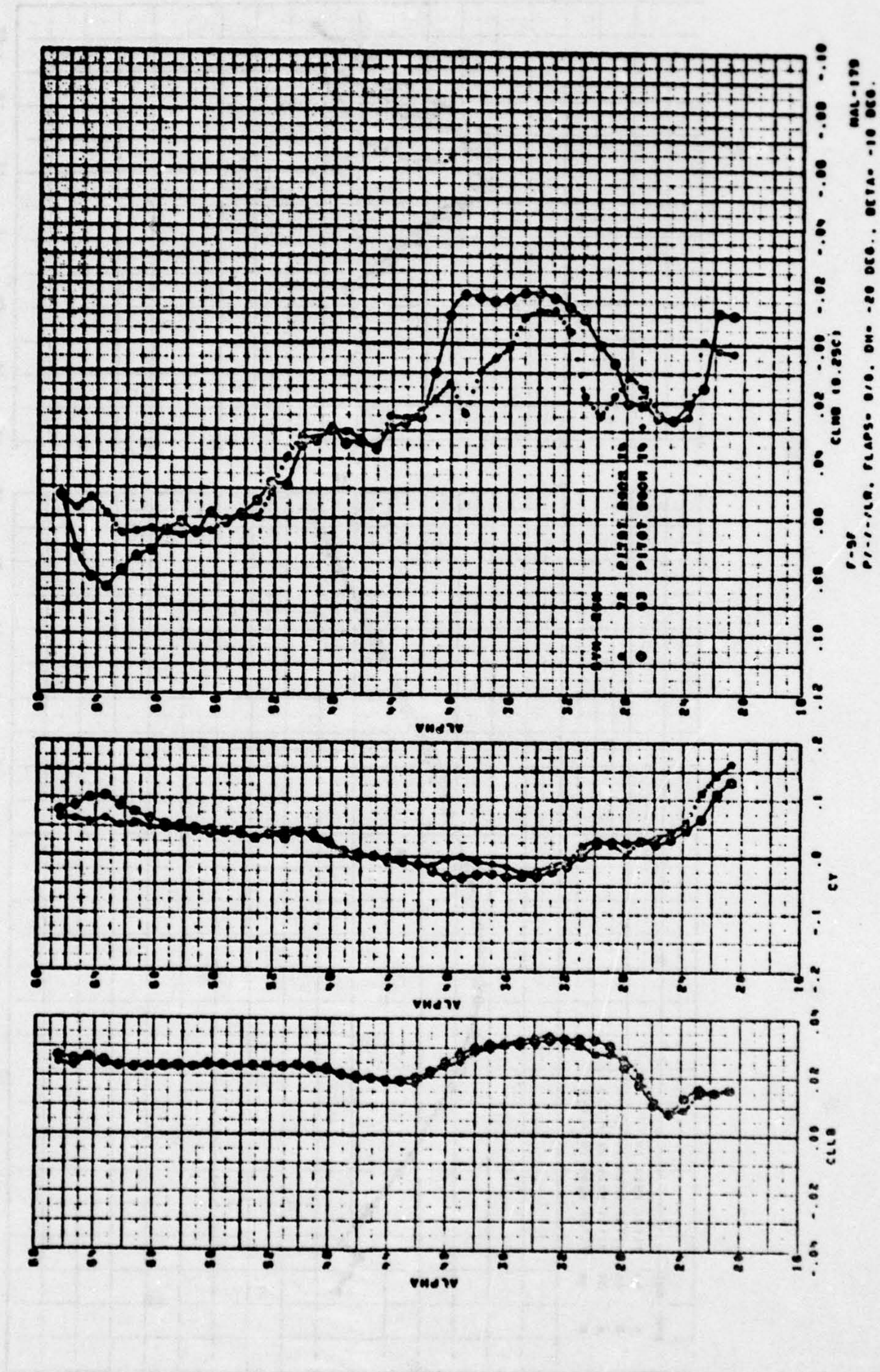


Figure 340. Effect of Lower Strakes S11

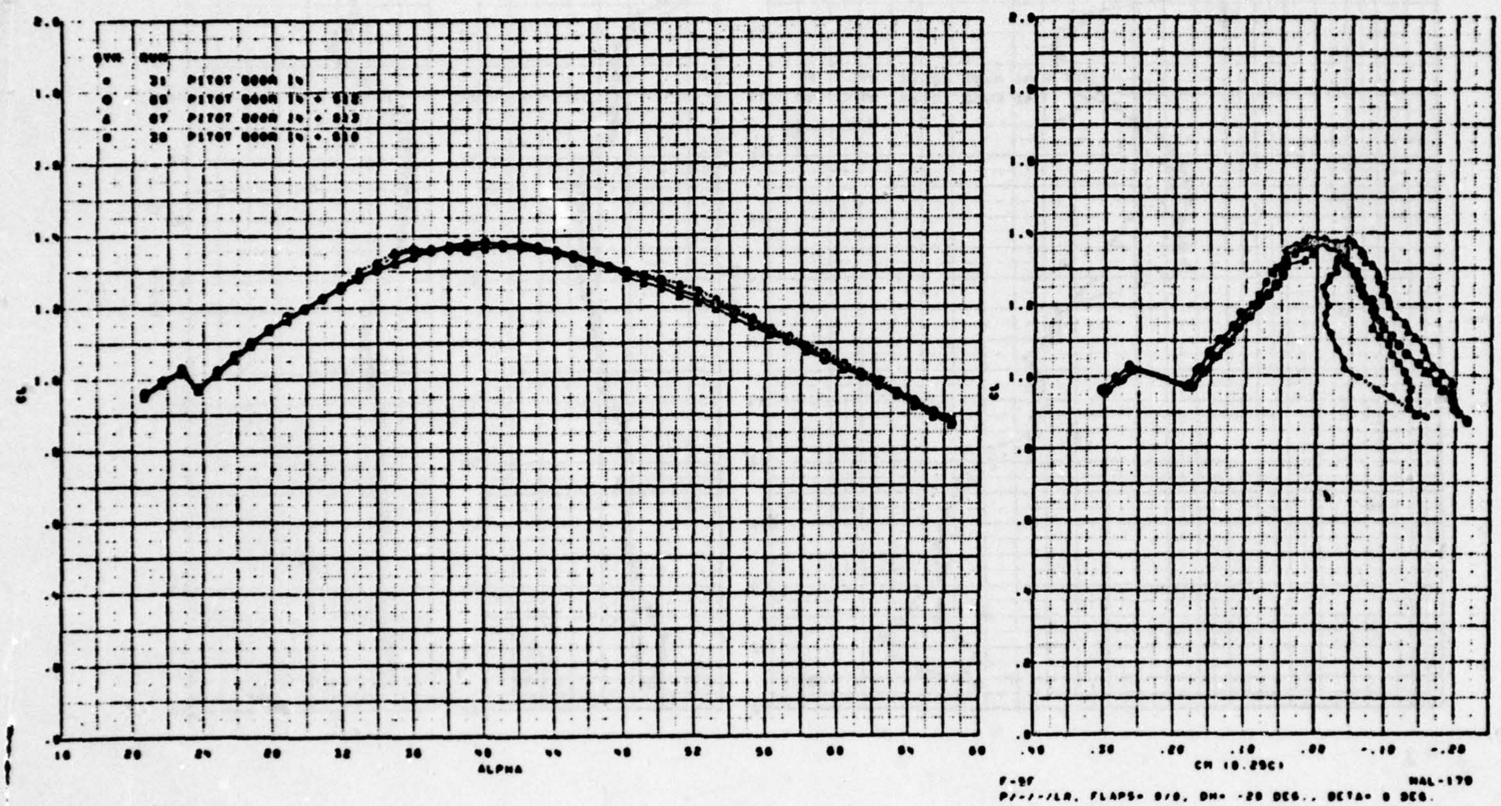


Figure 341. Effect of Strake Length S10, S12, S13

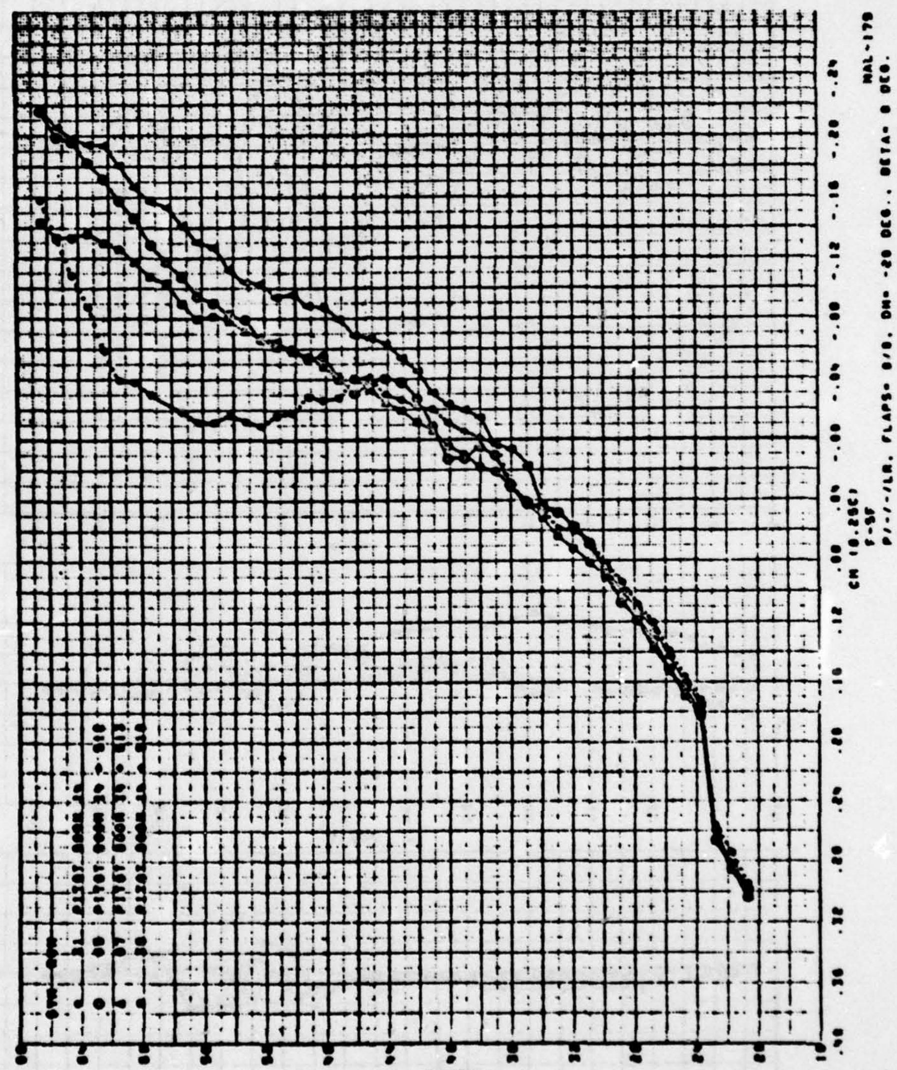


Figure 342. Effect of Strake Length S10, S12, S13

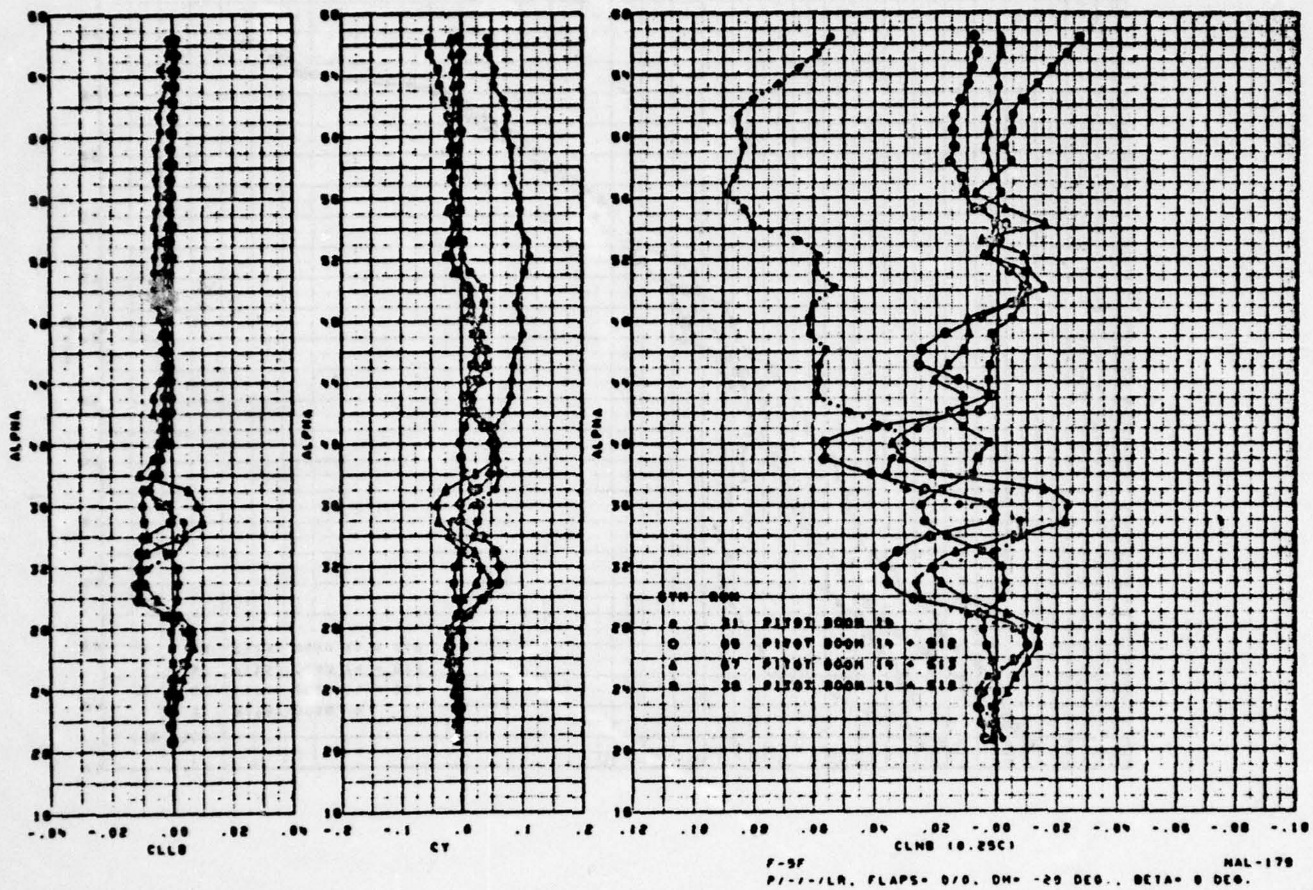


Figure 343. Effect of Strake Length S10, S12, S13

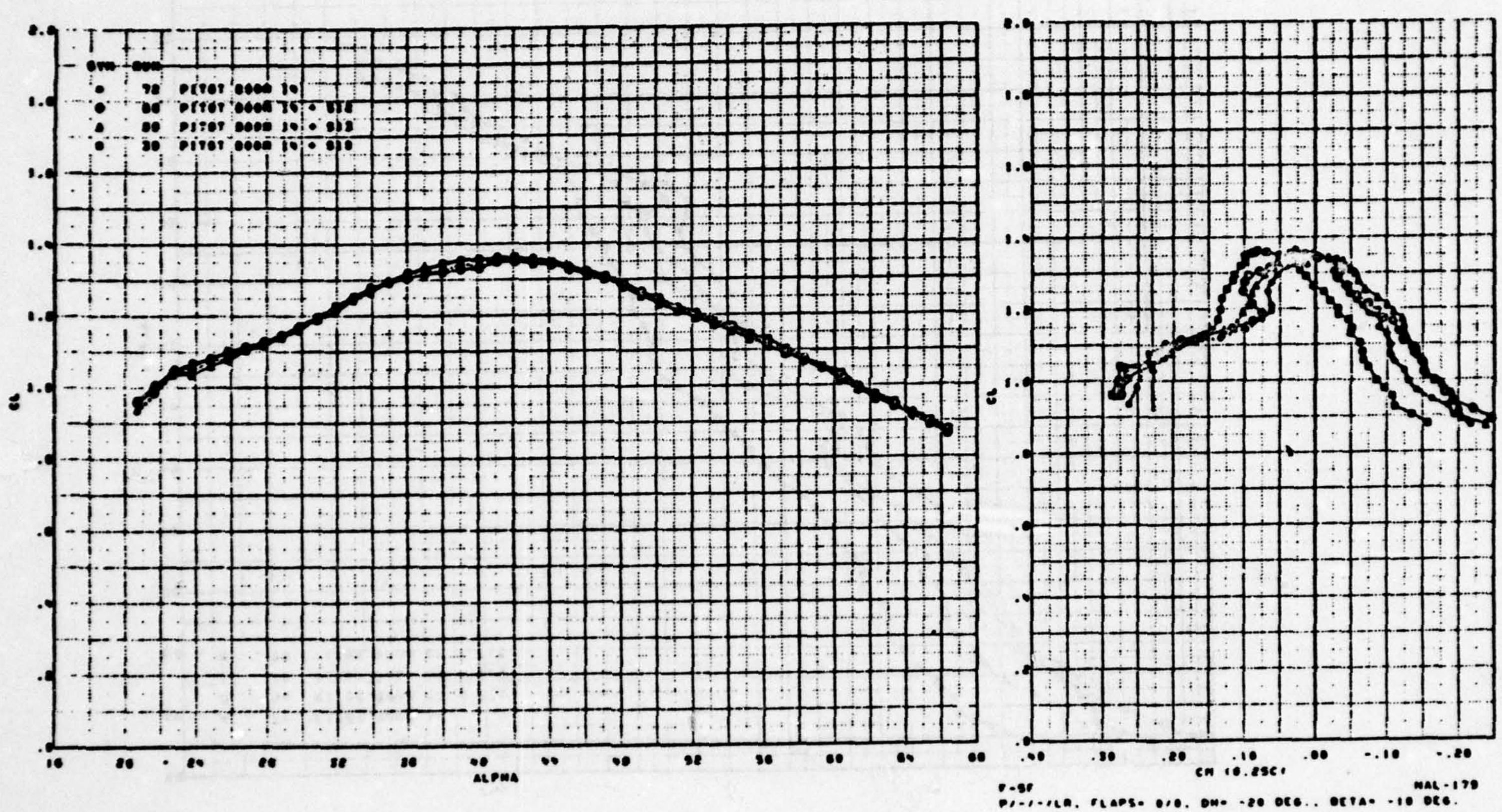


Figure 344. Effect of Strake Length S10, S12, S13

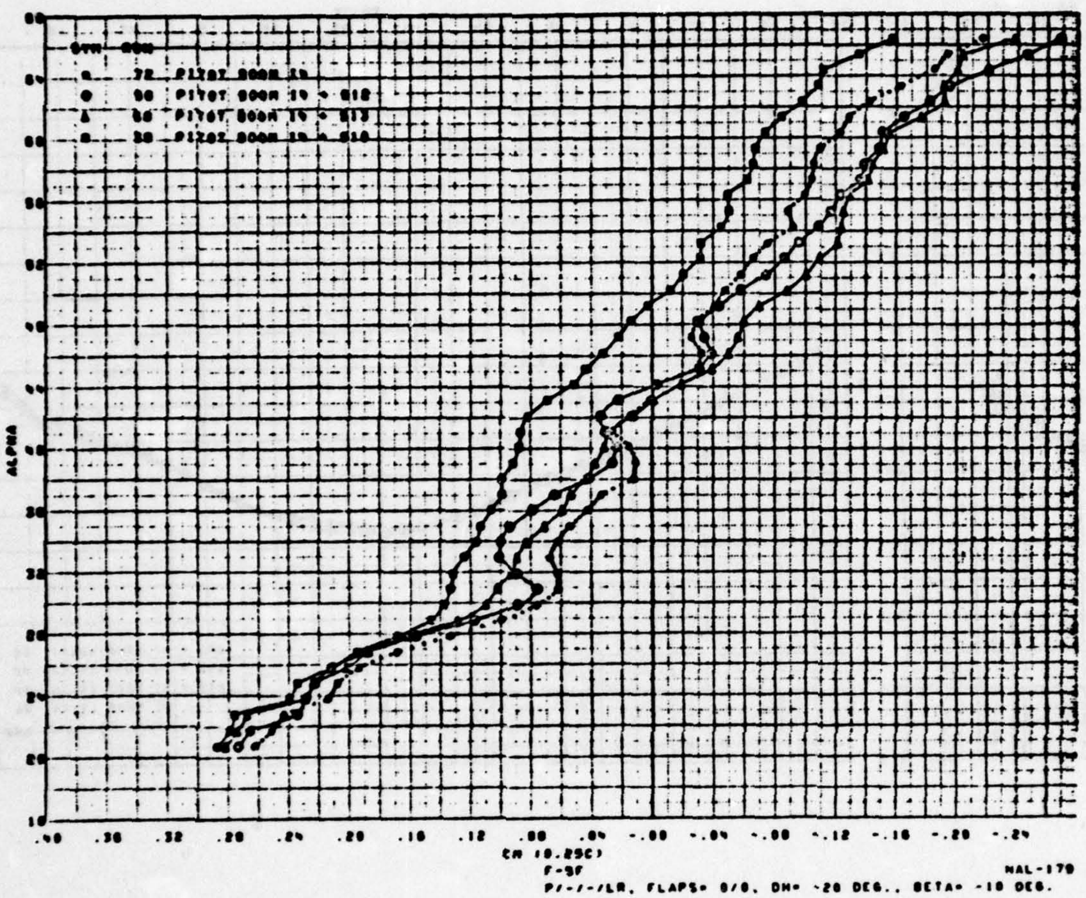


Figure 345. Effect of Strake Length S10, S12, S13

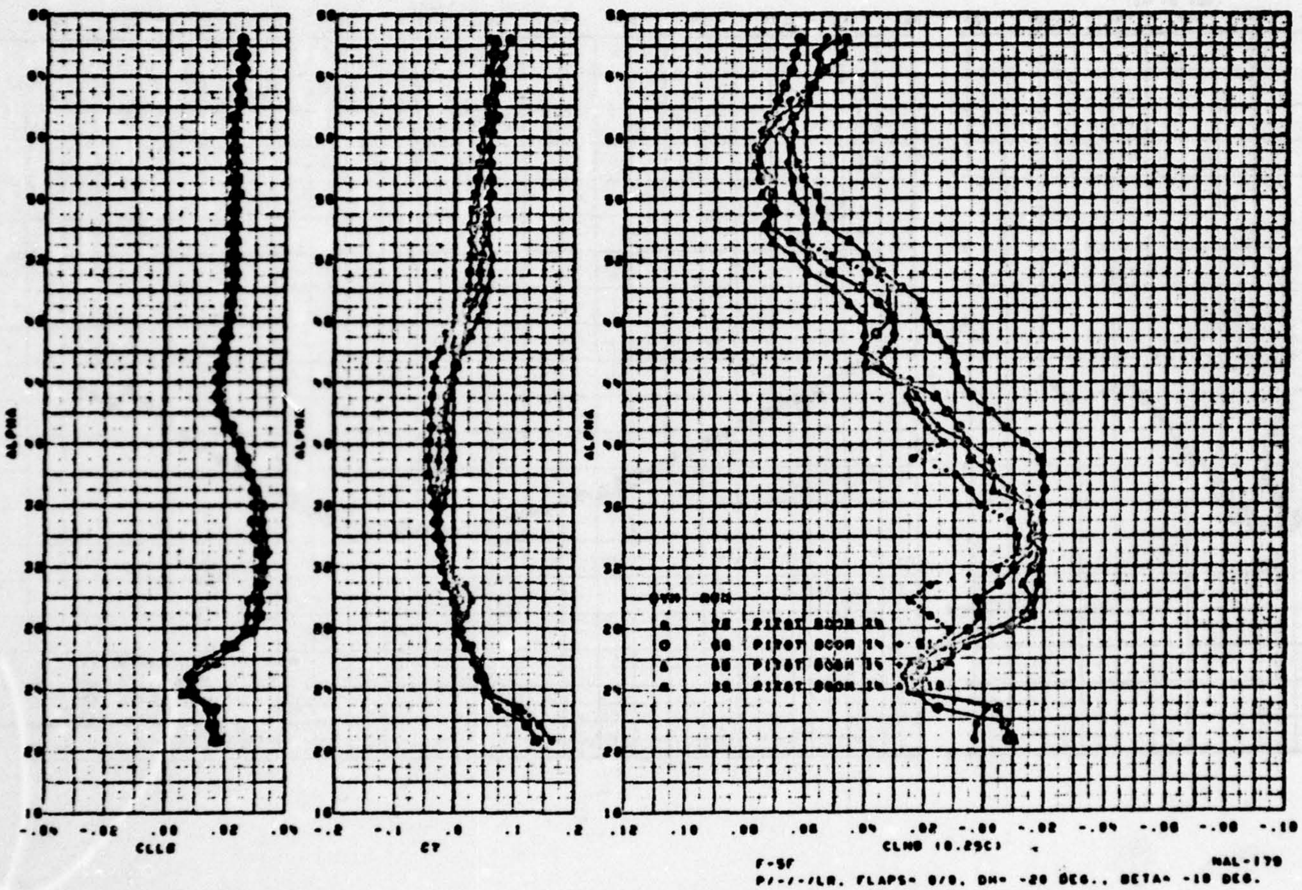


Figure 346. Effect of Strake Length S10, S12, S13

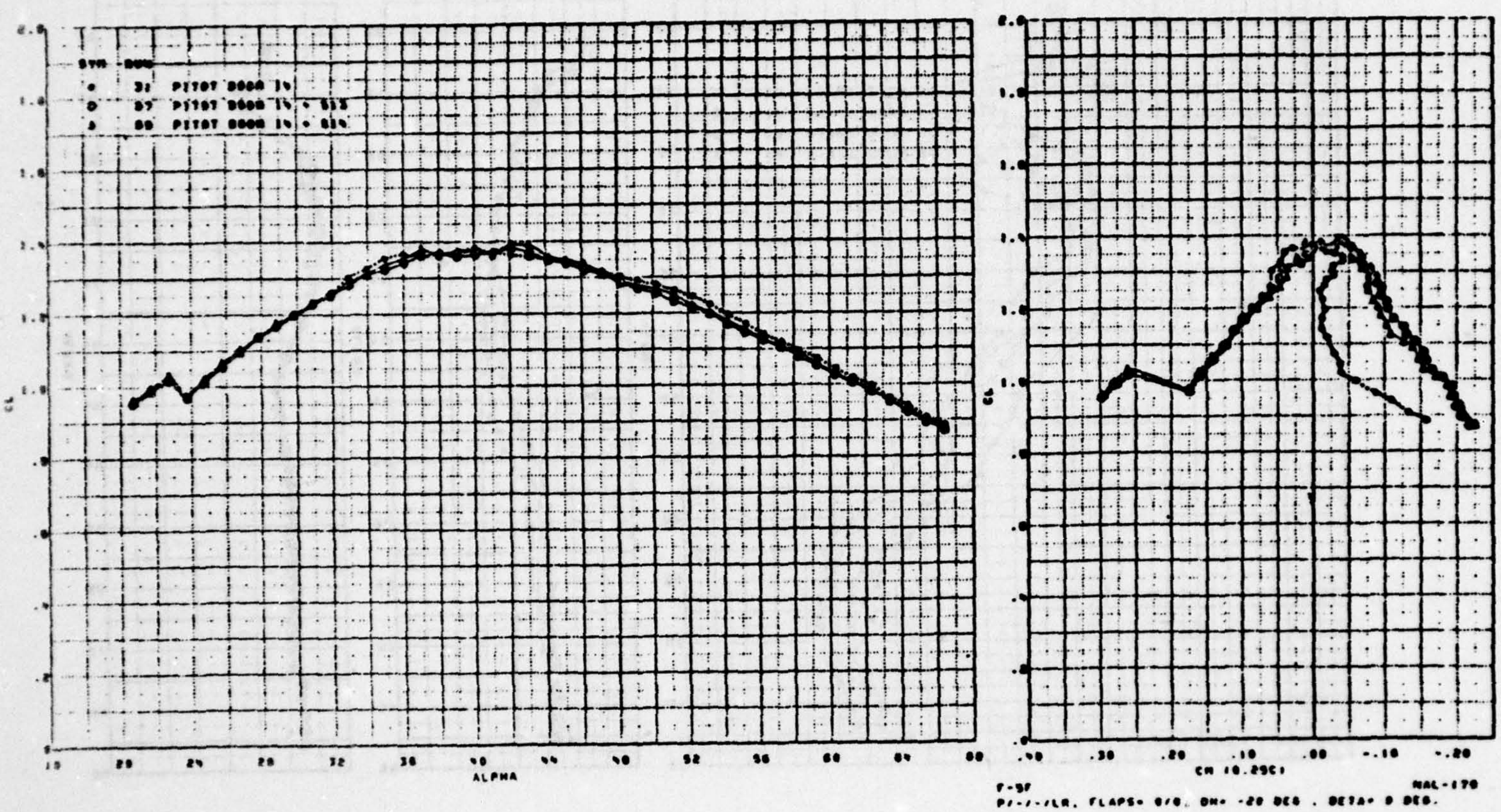


Figure 347. Effect of Strake Fairing S13, S14

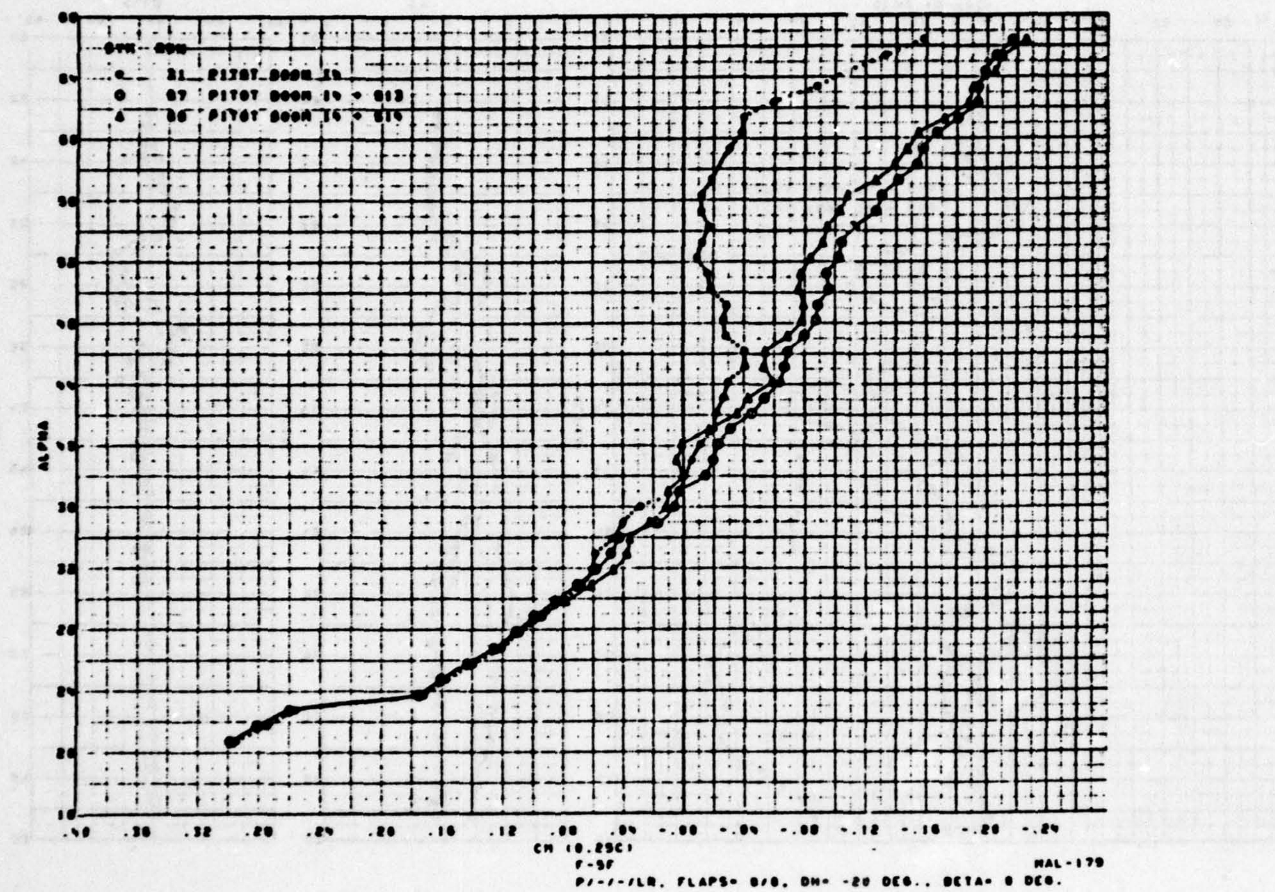


Figure 348. Effect of Strake Fairing S13, S14

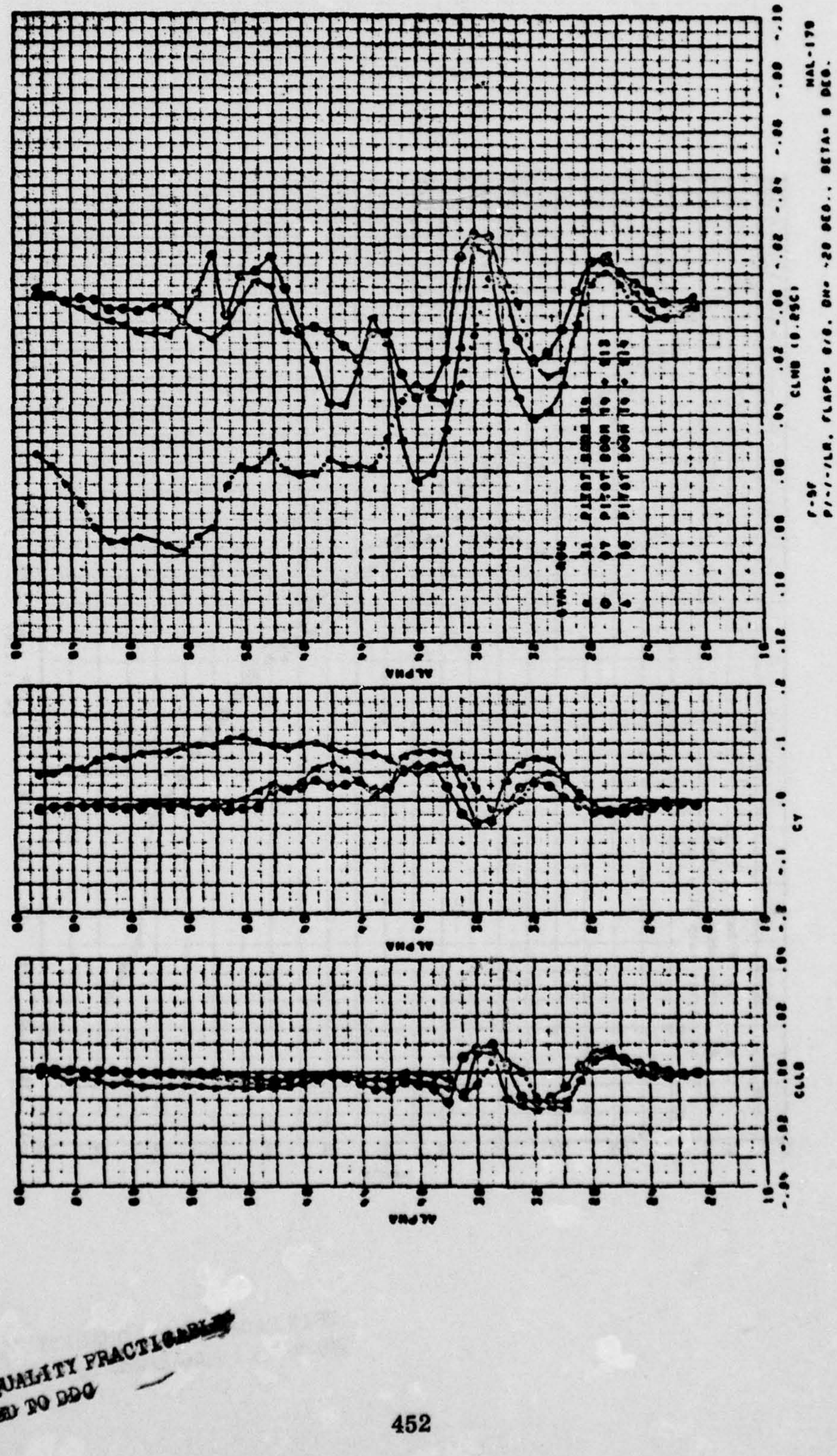


Figure 349. Effect of Strake Fairing S13, S14

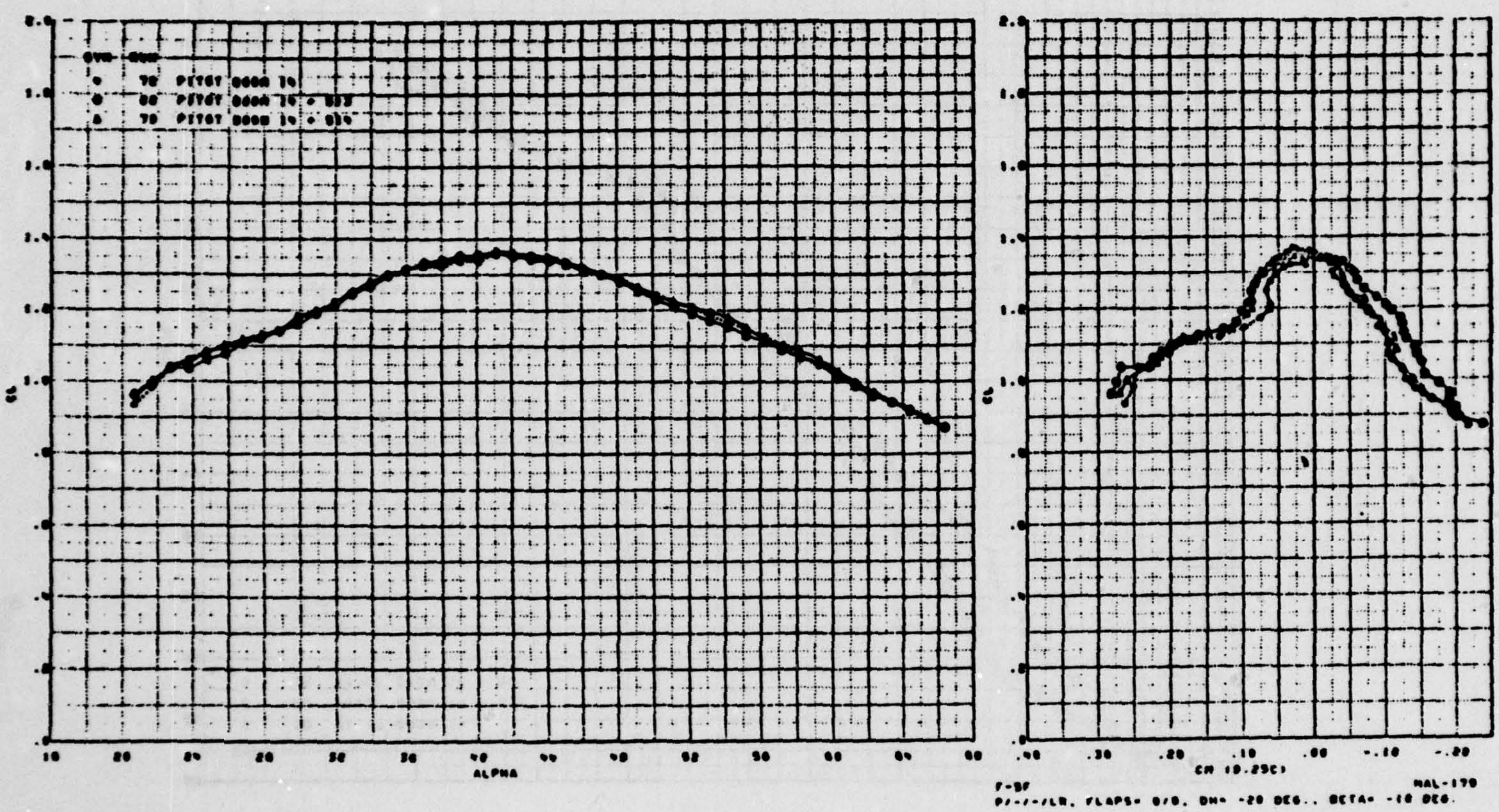


Figure 350. Effect of Strake Fairing S13, S14

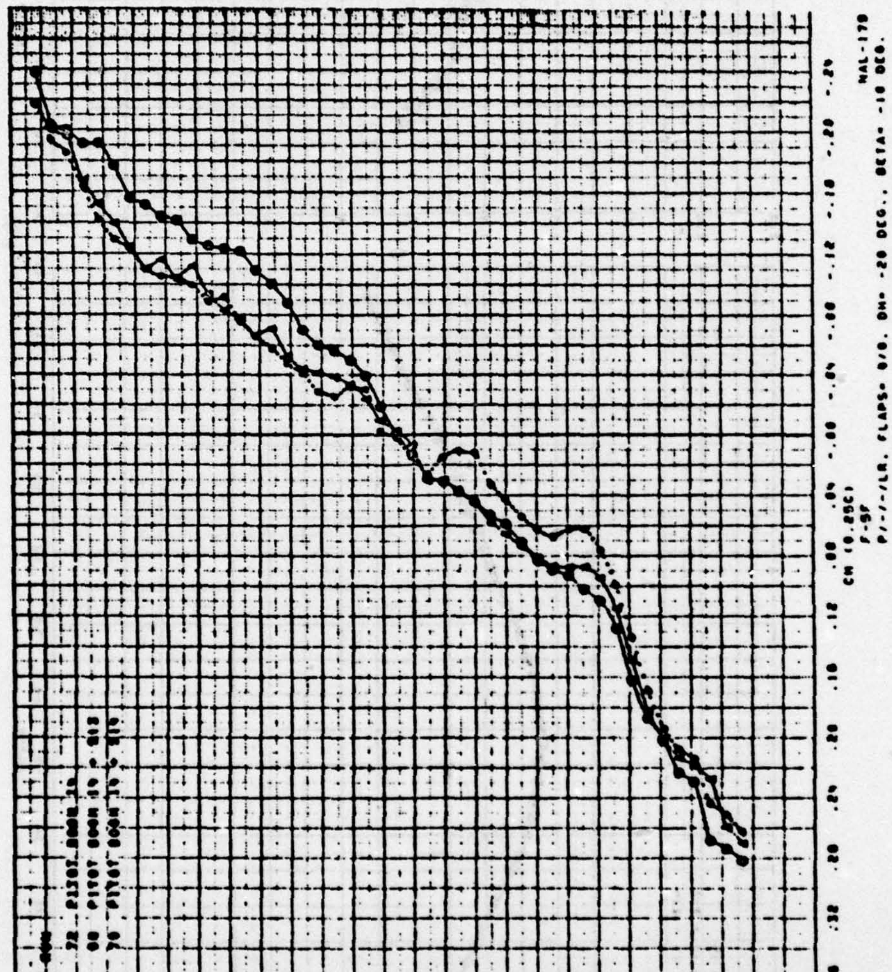


Figure 351. Effect of Strake Fairing S13, S14

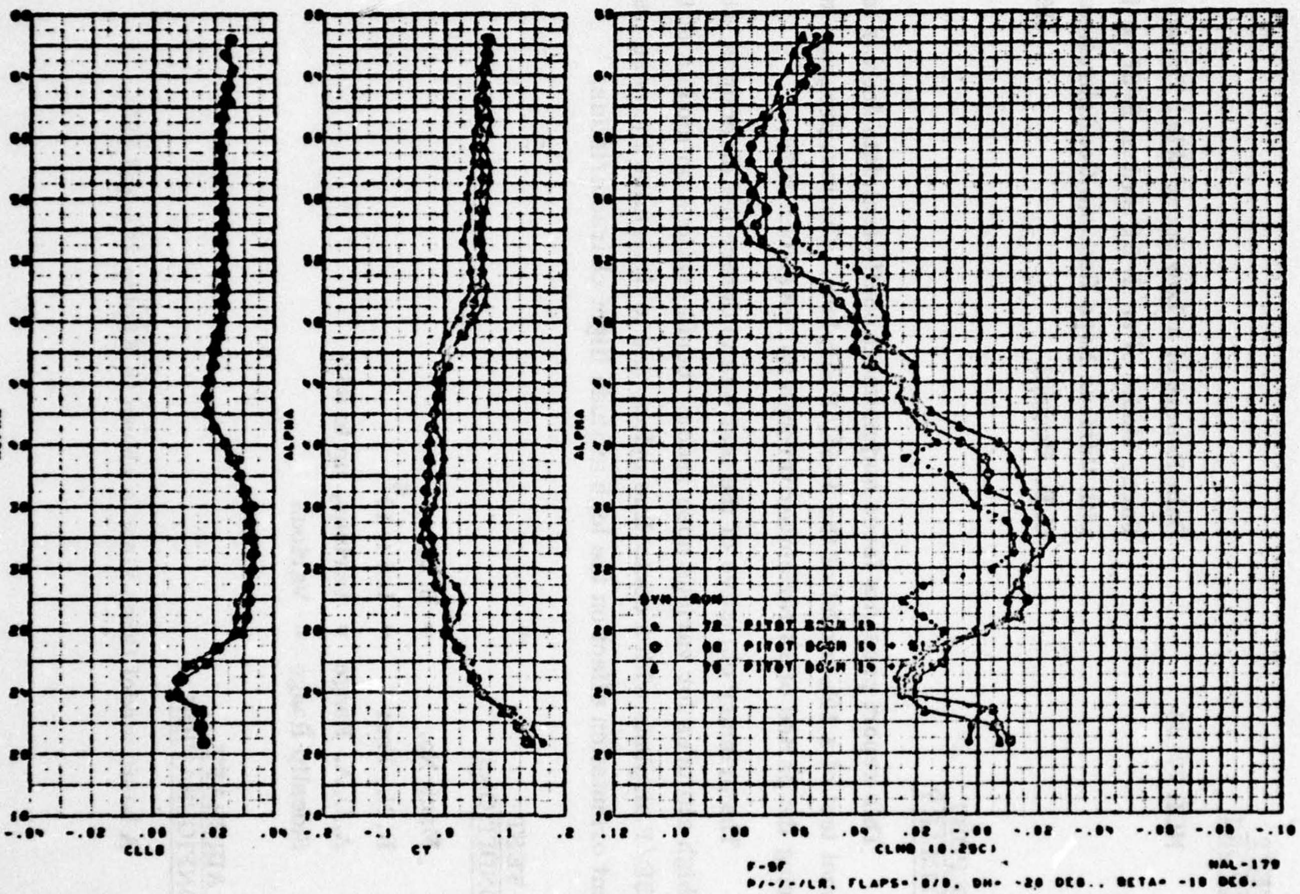


Figure 352. Effect of Strake Fairing S13, S14

AIRCRAFT	F-5E/F	REFERENCE	55

TEST REPORT

NOR 77-86 — Data Report of a Low Speed Wind Tunnel Test of a 10% Force Model of an F-5F and an F-5E at High Attitudes with Various Nose Radome Configurations

G. B. Bennett NAL-184

REPORT SUMMARY

This report presents force and moment coefficient data from a low speed wind tunnel test of a 10% model of the F-5E/F airplane. The test program was conducted during the period of 13 November through 24 November 1976.

The primary objective of the test was to determine directional stability trends at high attitudes for various nose radome configurations on models of the production F-5E/F airplane with a centerline pylon, and to determine the nose radome attachment orientation effect on the high attitude flight characteristics.

TEST CONDITIONS

Mach No.	=	0.26
R. N./Foot	=	1.5×10^6
A. O. A. Range	=	Various, up to 65°
Sideslip Range	=	Various

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 208 and 222.

CONFIGURATION CHANGES

Sketches of F-5E and F-5F nose bluntness and pitot boom configuration changes applicable to this study are shown in Figures 353, 354 and 357.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figures 355 and 356 show the effect on lateral/directional characteristics at zero sideslip of F-5E and F-5F nose bluntness, B32 and B30 respectively.

A similar plot is shown in Figure 358 for the effect of pitot booms i_4, i_{12}, i_{13} and i_{14}.

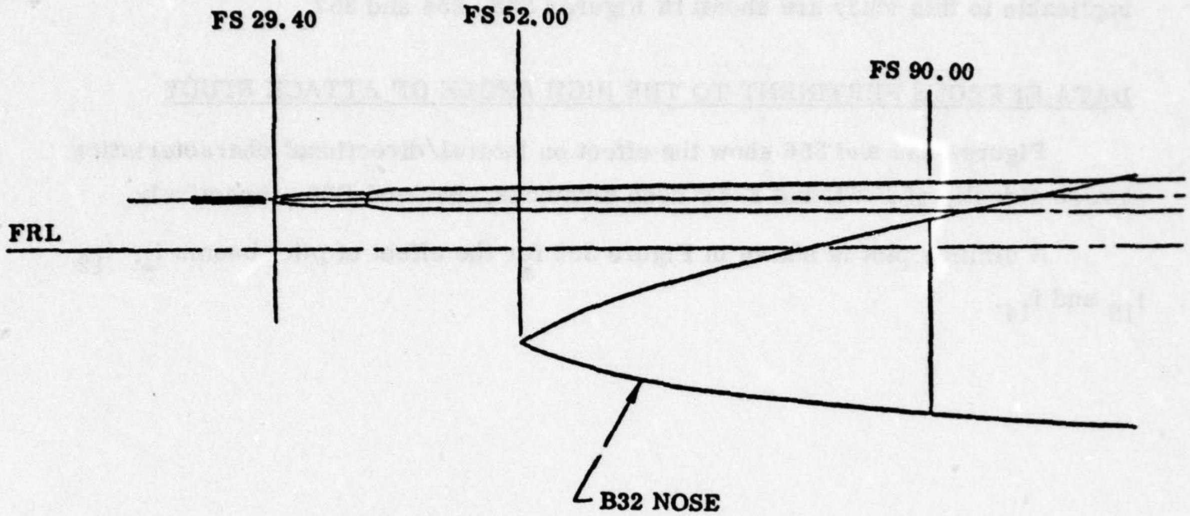
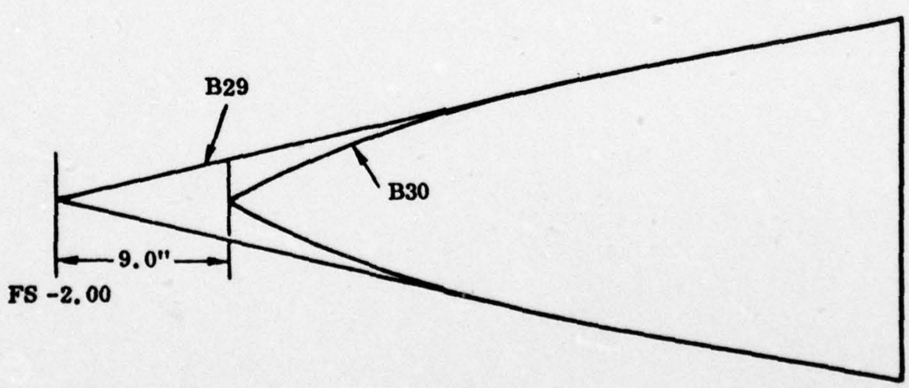


Figure 353. Increased Nose Bluntness, F-5E



PROFILE VIEW

Figure 354. Increased Nose Bluntness, F-5F

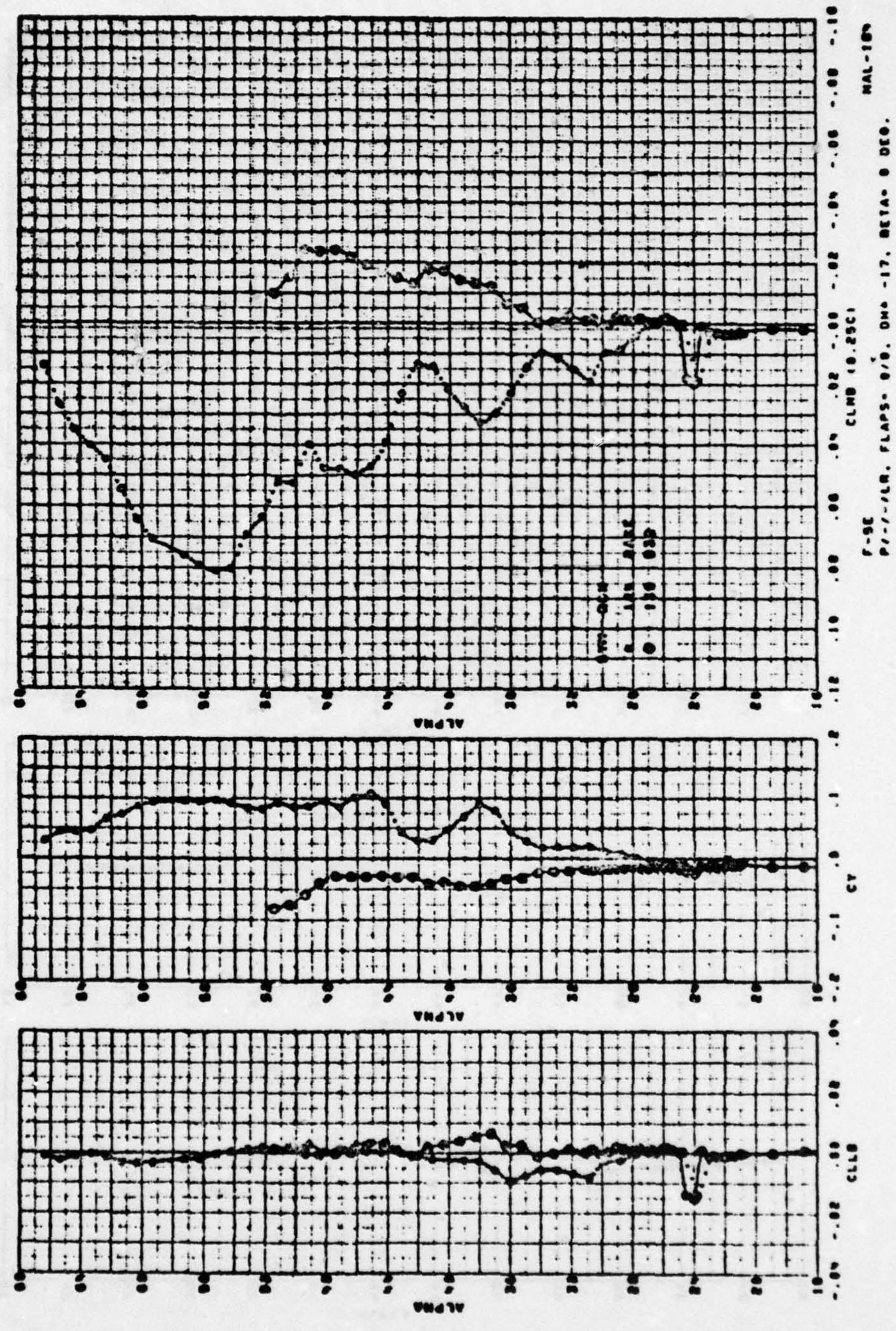


Figure 355. Effect of Nose Bluntness

AD-A069 647 NORTHROP CORP HAWTHORNE CA AIRCRAFT GROUP F/G 20/4
ANALYSIS OF WIND TUNNEL DATA PERTAINING TO HIGH ANGLE OF ATTACK--ETC(U)
JUL 78 J W HEADLEY F33615-77-C-3062
UNCLASSIFIED NOR-78-69-VOL-2 AFFDL-TR-78-94-VOL-2 NL

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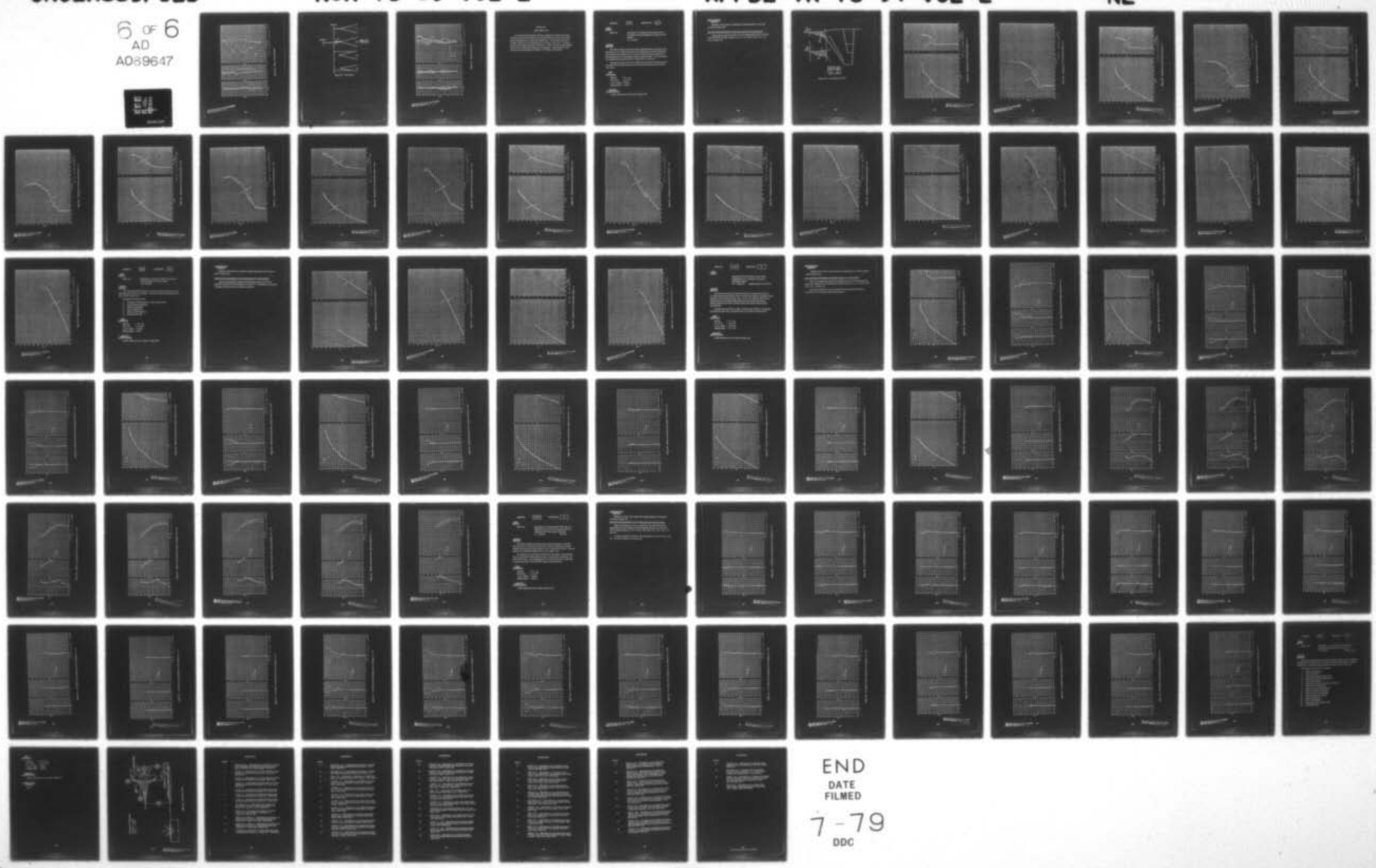

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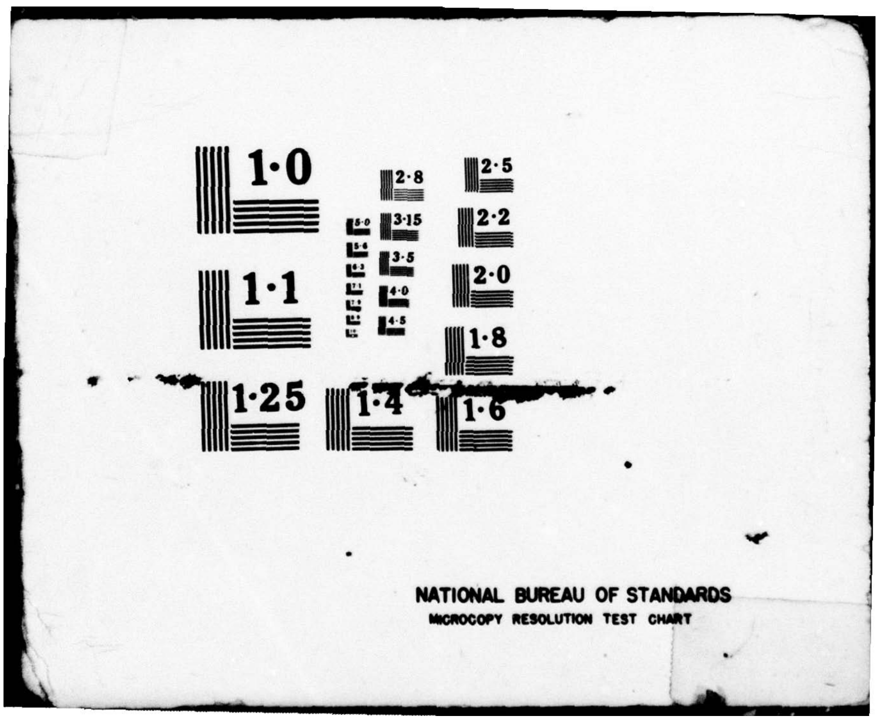
1·0
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1·4
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NATIONAL BUREAU OF STANDARDS
MICROCOPY RESOLUTION TEST CHART

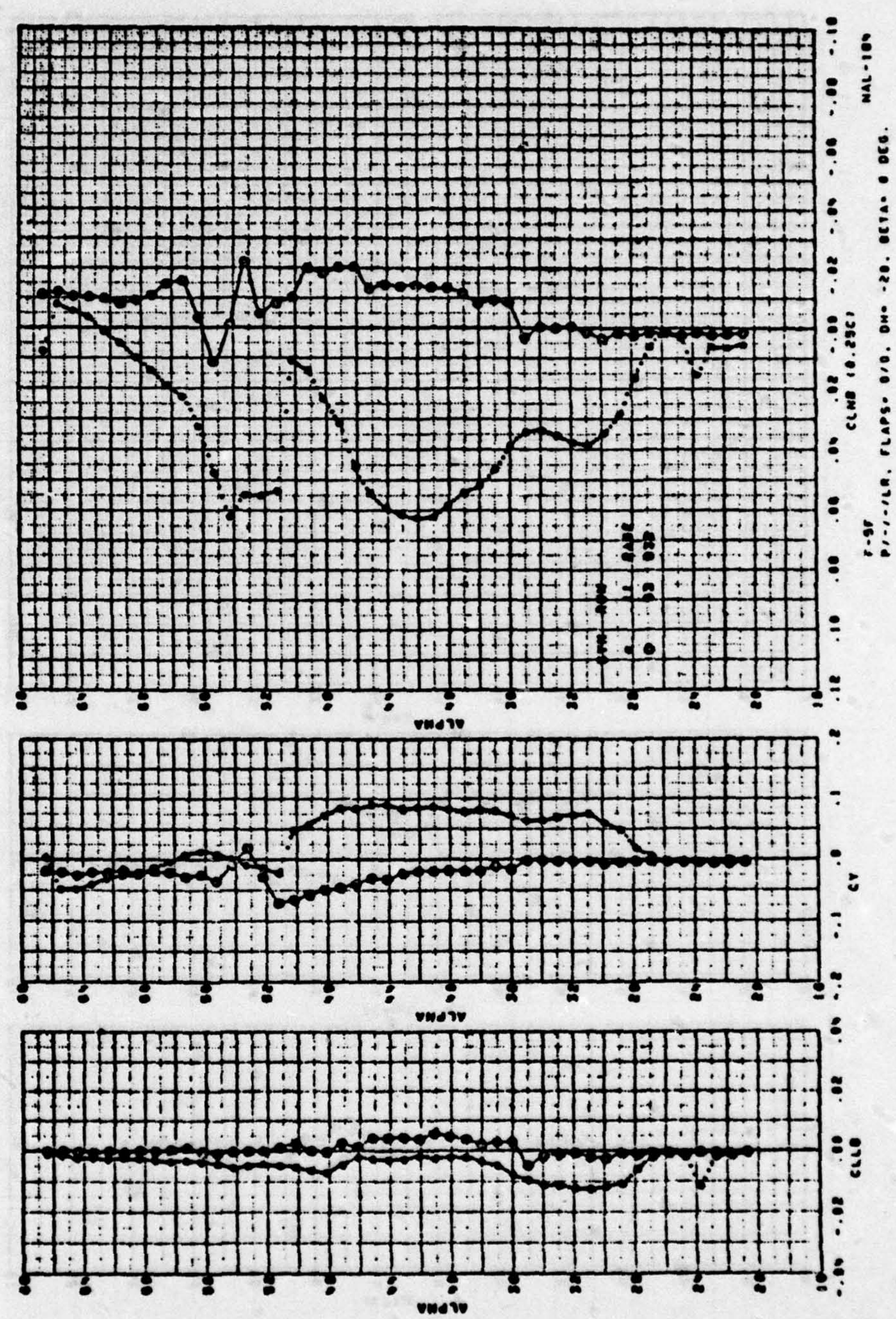


Figure 356. Effect of Nose Bluntness

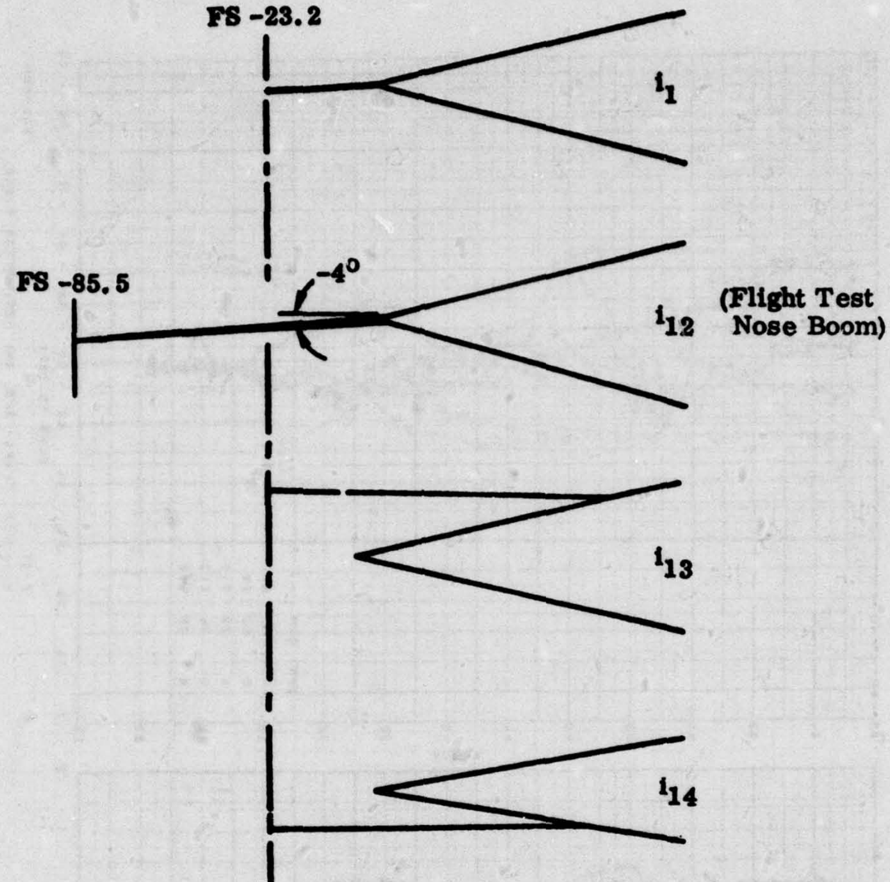


Figure 357. Pitot Booms

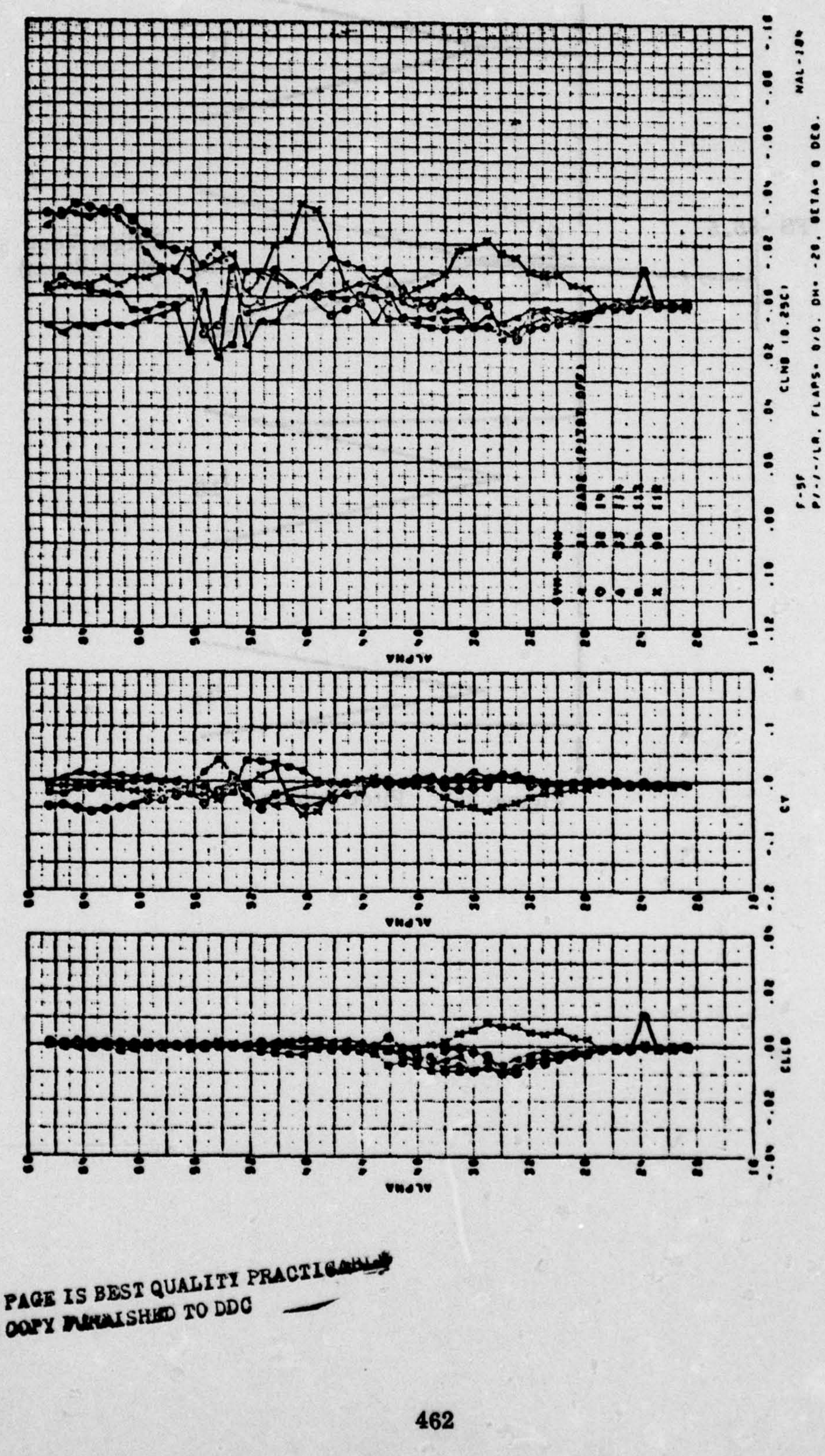


Figure 358. Effect of Pitot Booms

SECTION IX

HIGH SPEED DATA

As was discussed previously, the major configuration studies were largely conducted in the low speed tunnel, the high speed testing was reserved for performance investigations on a single basic configuration. Consequently little data is available transonically and supersonically for inclusion in this study. Moreover, the high speed data was obtained at somewhat low angles of attack, further restricting its use for a high angle of attack data investigation. All the high speed tests referred to in the discussions in Volume I are included in this section.

AIRCRAFT **F-5E** REFERENCE **56**

TEST REPORT

NOR 72-67 — Data Report of a Transonic Wind Tunnel Test of a 0.10 Scale F-5E Force Model in the AEDC 16T Test Facility

B. G. Franco

REPORT SUMMARY

This report presents force and moment coefficient data for a transonic wind tunnel test of a 0.10 scale model of the F-5E conducted at the Arnold Engineering Development Center (AEDC) 16 Foot Transonic Wind Tunnel and is intended as a data supplement to the documentation report released by AEDC. The test program was conducted during the period from 8 March 1971 to 9 April 1971.

The objectives of the test were to obtain basic aerodynamic characteristics of the model with and without external stores and horizontal tail panel and external store loads.

TEST CONDITIONS

Mach No. = 0.3 - 1.5

R.N./Foot = 2.0×10^6

A.O.A. Range = Various

Sideslip Range = Various

AIRCRAFT CONFIGURATION

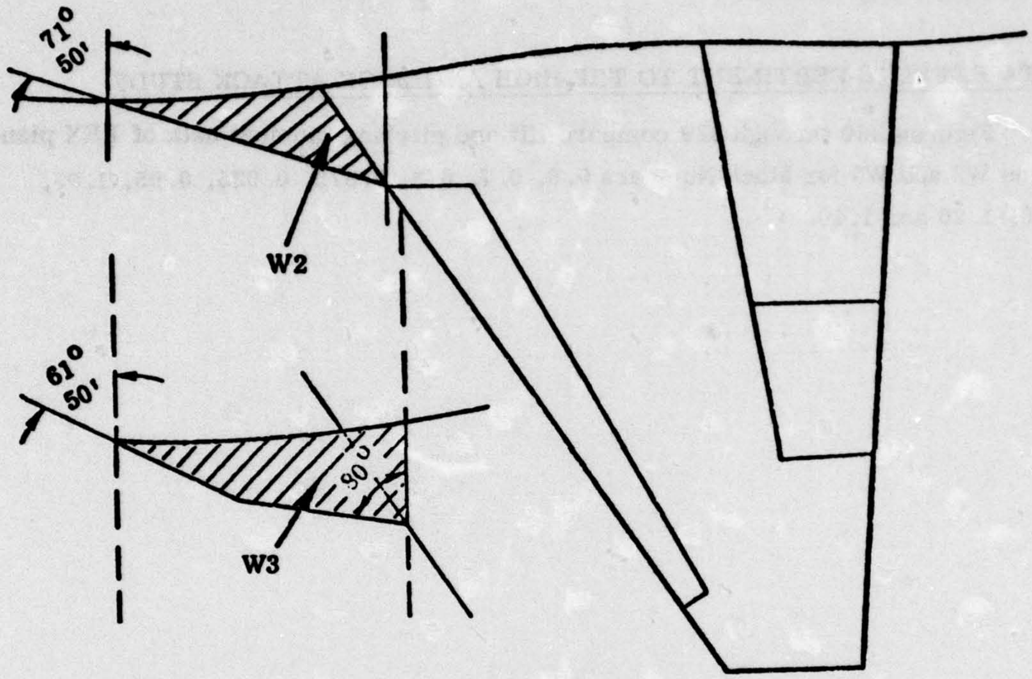
A basic model three view is shown in Figure 208.

CONFIGURATION CHANGES

Sketches of LEX planform configuration changes applicable to this study are shown in Figure 359.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figures 360 through 379 compare lift and pitching moment data of LEX planforms W2 and W3 for Mach Numbers 0.6, 0.7, 0.8, 0.875, 0.925, 0.95, 1.05, 1.10, 1.20 and 1.40.



LEX	S_L / S_W
W2	.031
W3	.043

Figure 359. Lex Planforms W2, W3

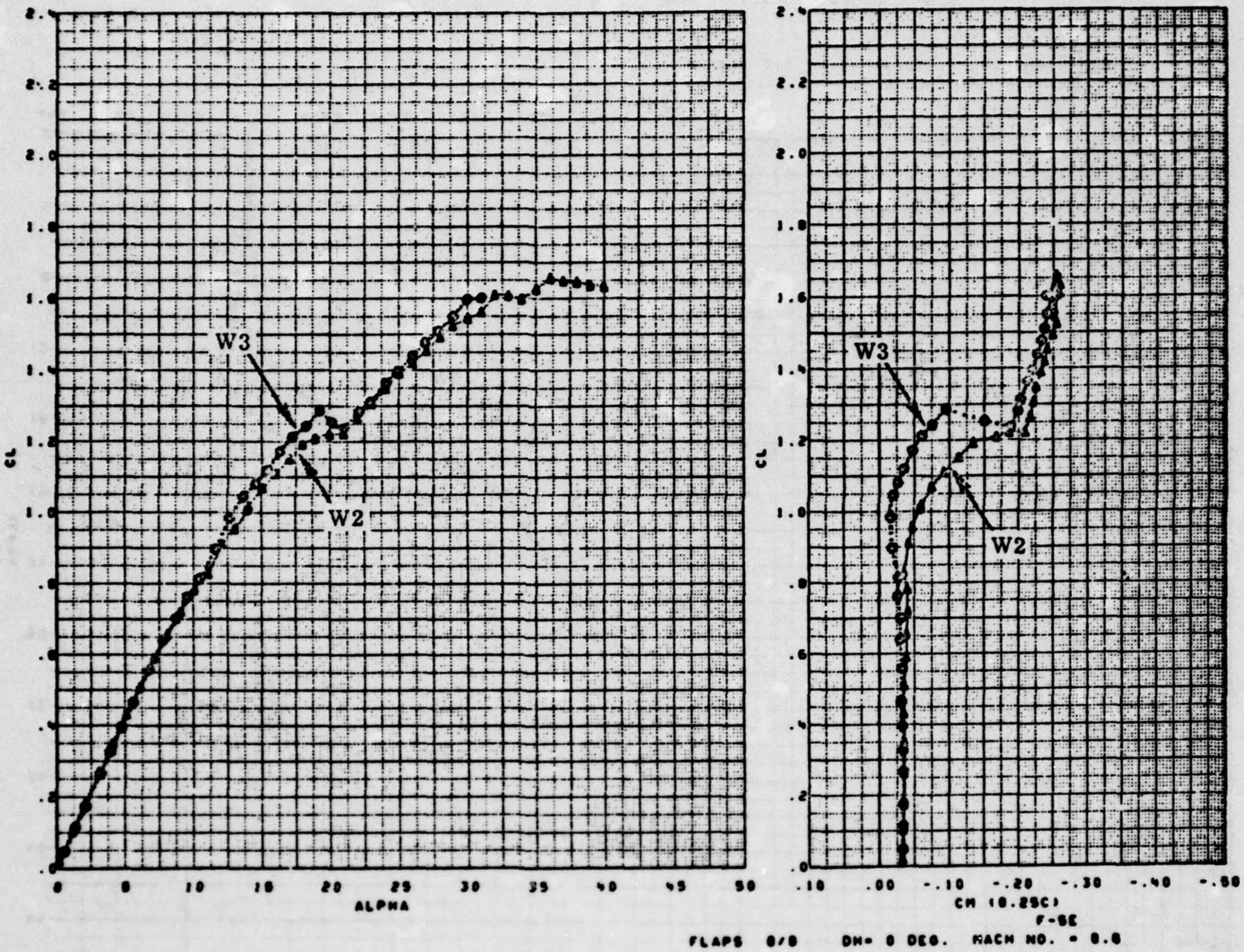


Figure 360. Comparison of Lex W2 and W3 at Mach = 0.6

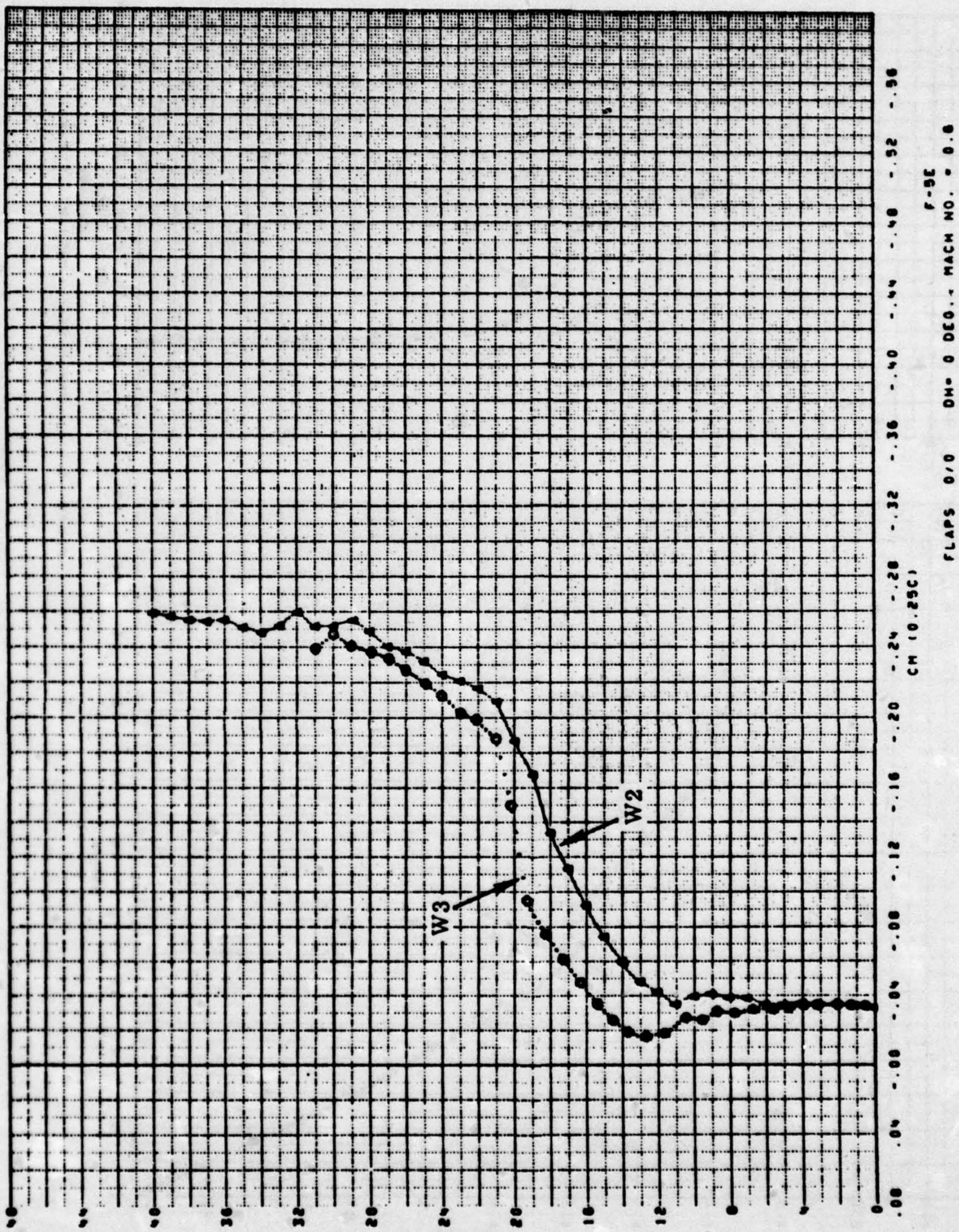


Figure 361. Comparison of Lex W2 and W3 at Mach = 0.6

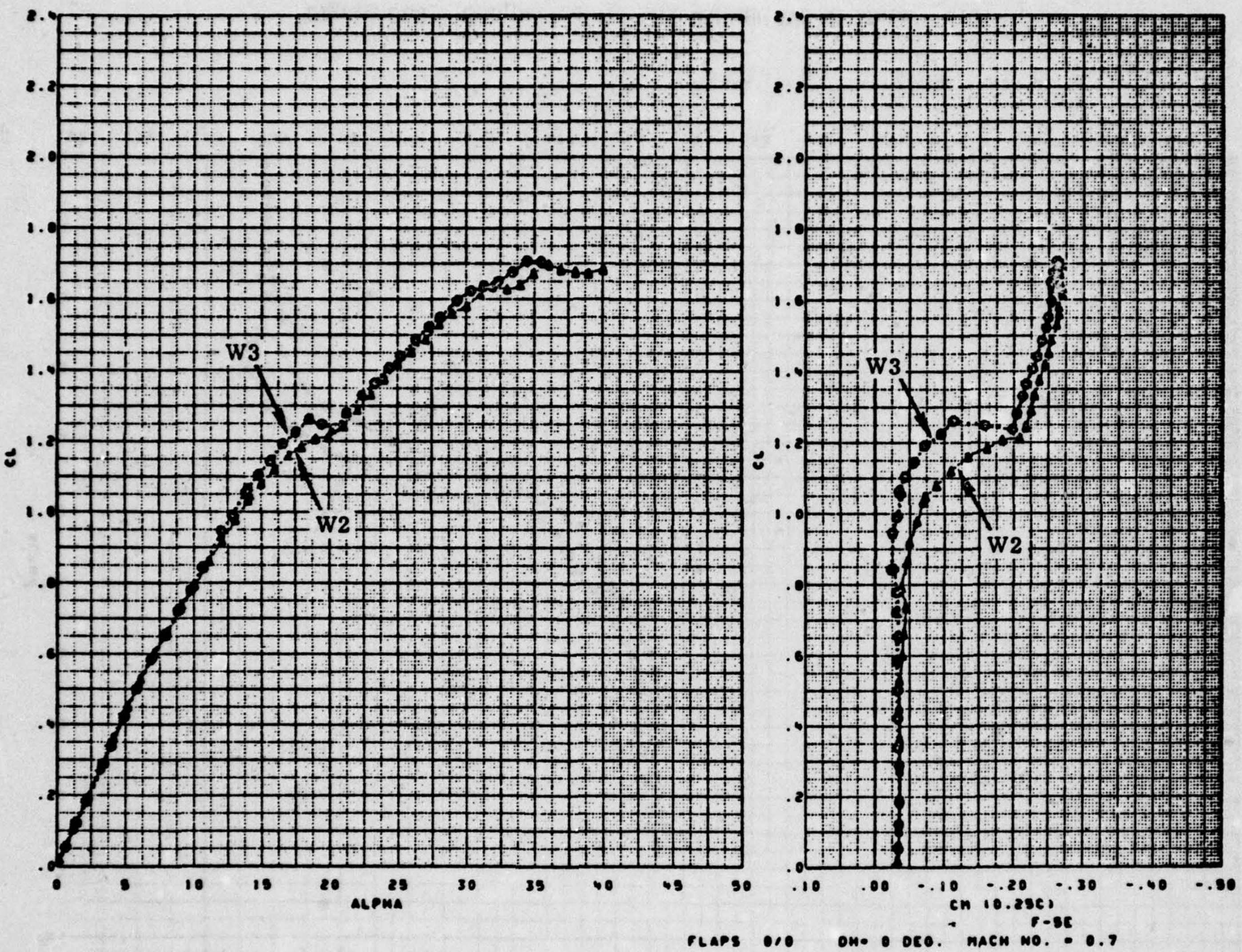


Figure 362. Comparison of Lex W2 and W3 at Mach = 0.7

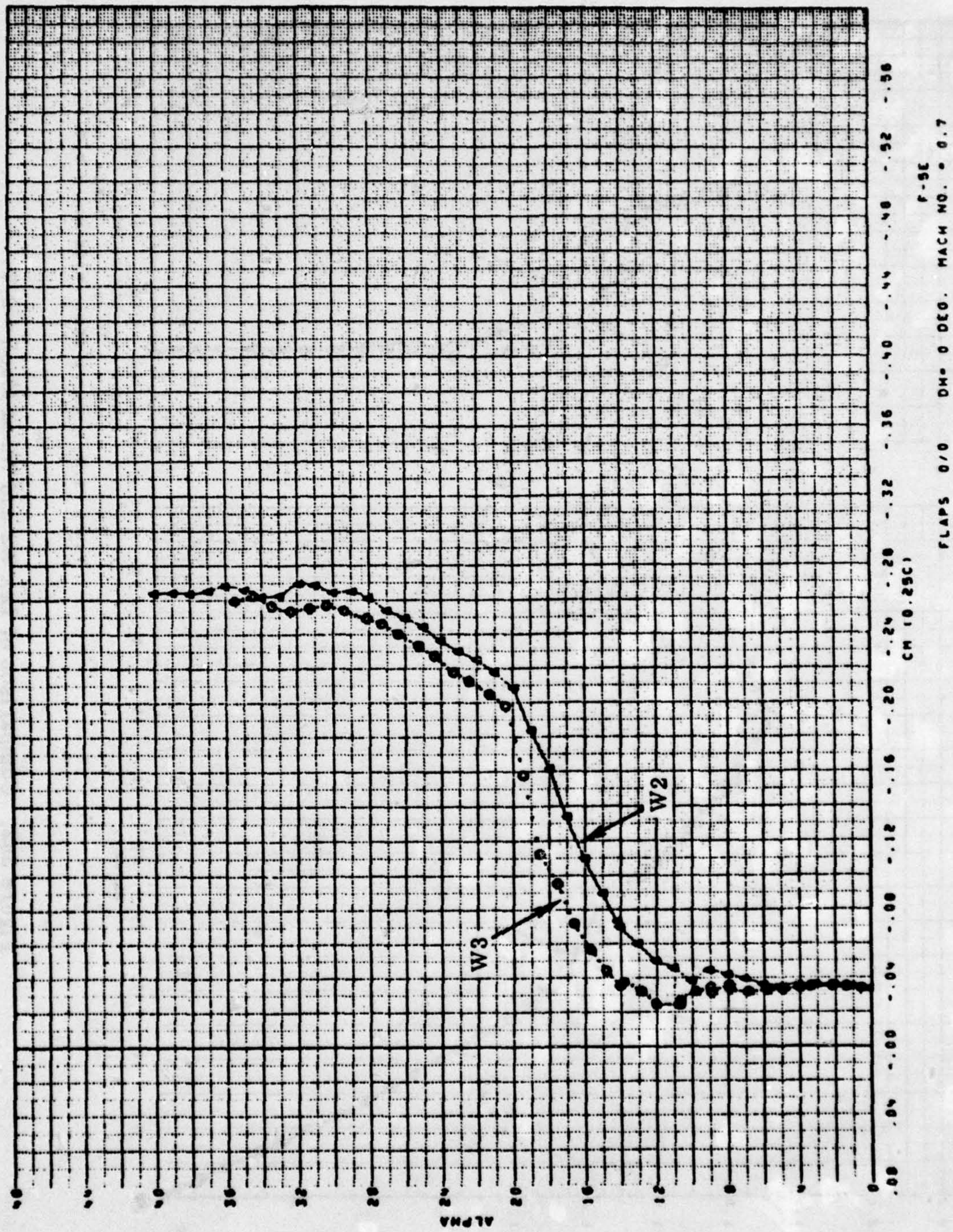


Figure 363. Comparison of Lex W2 and W3 at Mach = 0.7

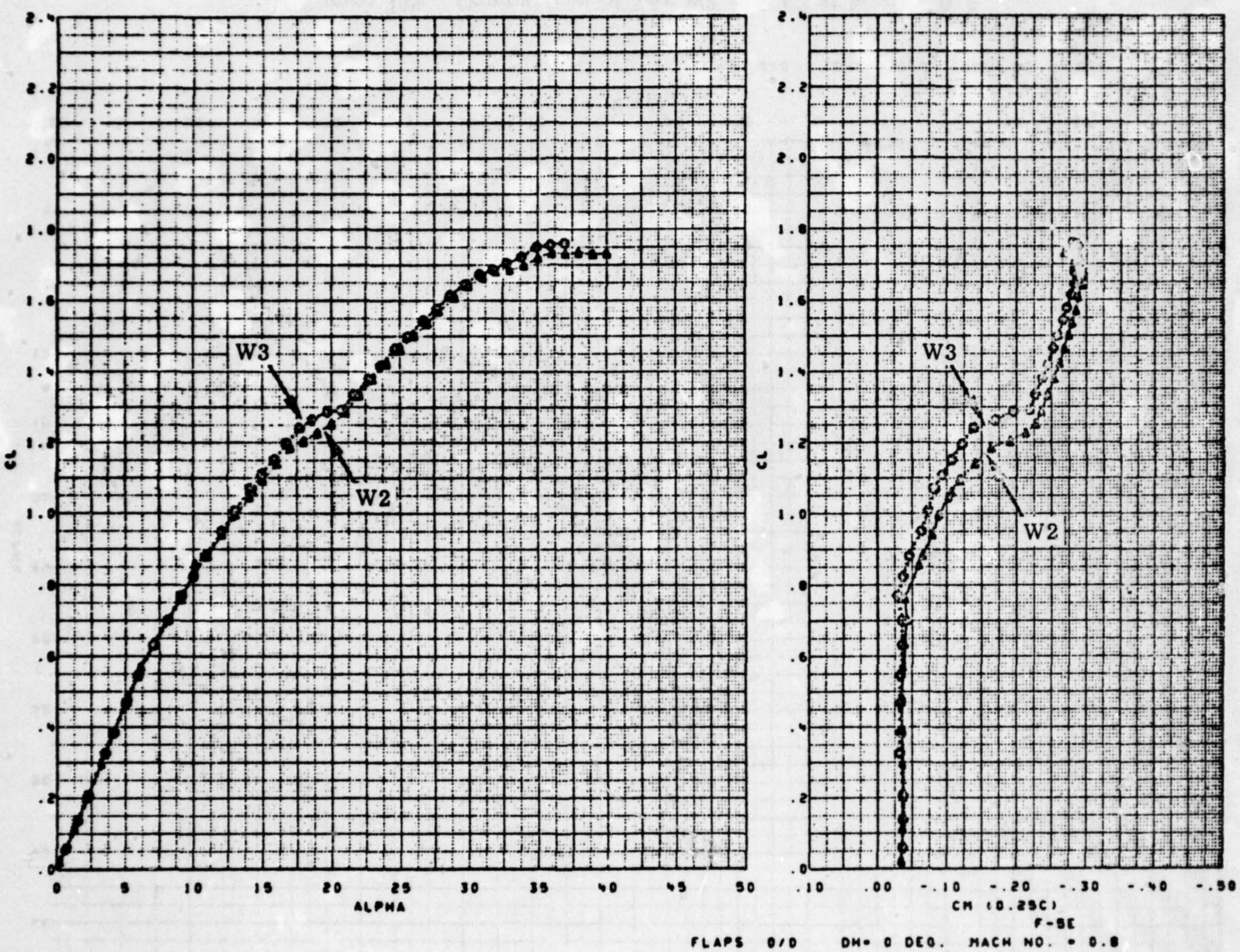


Figure 364. Comparison of Lex W2 and W3 at Mach = 0.8

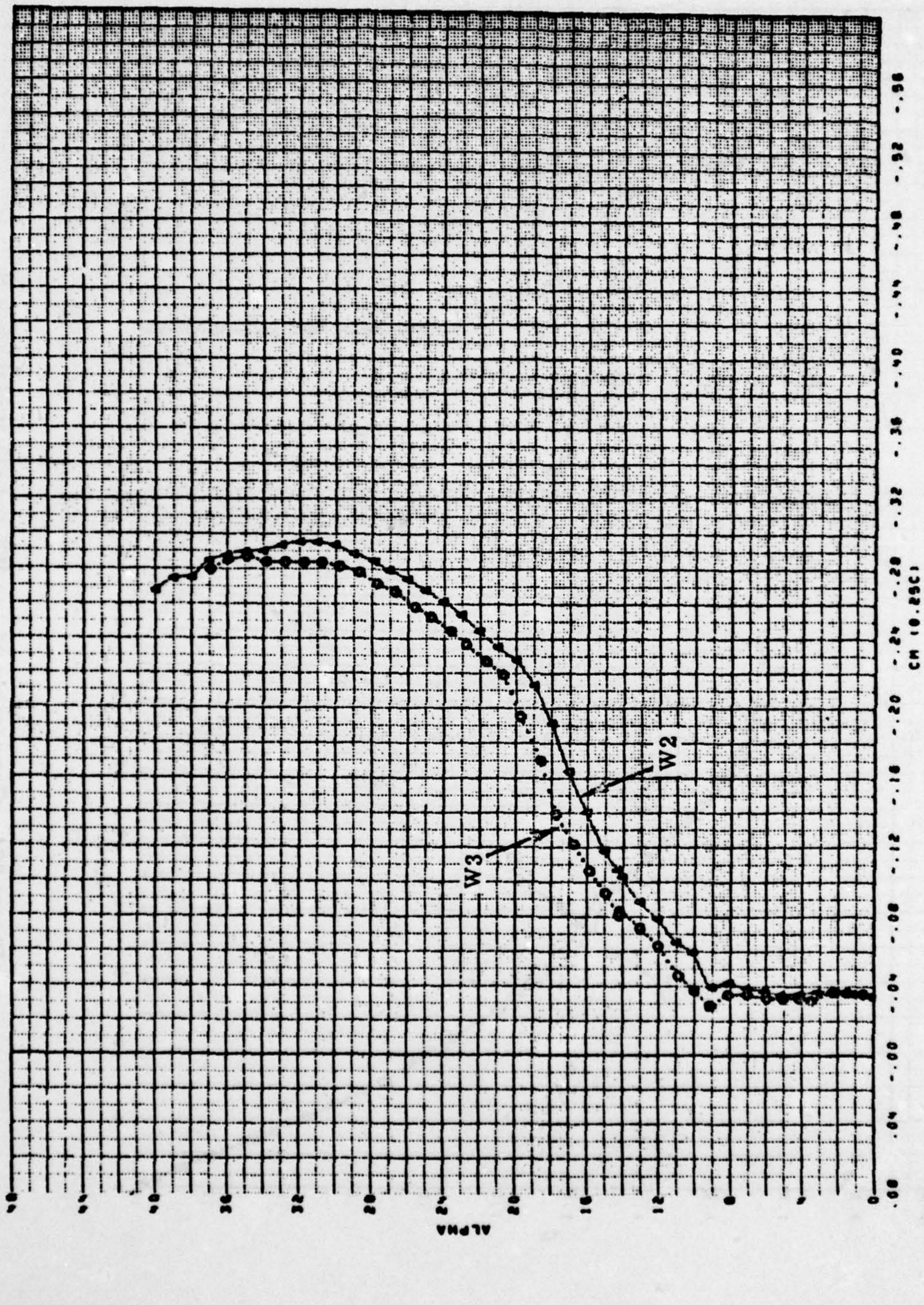


Figure 365. Comparison of Lex W2 and W3 at Mach = 0.8

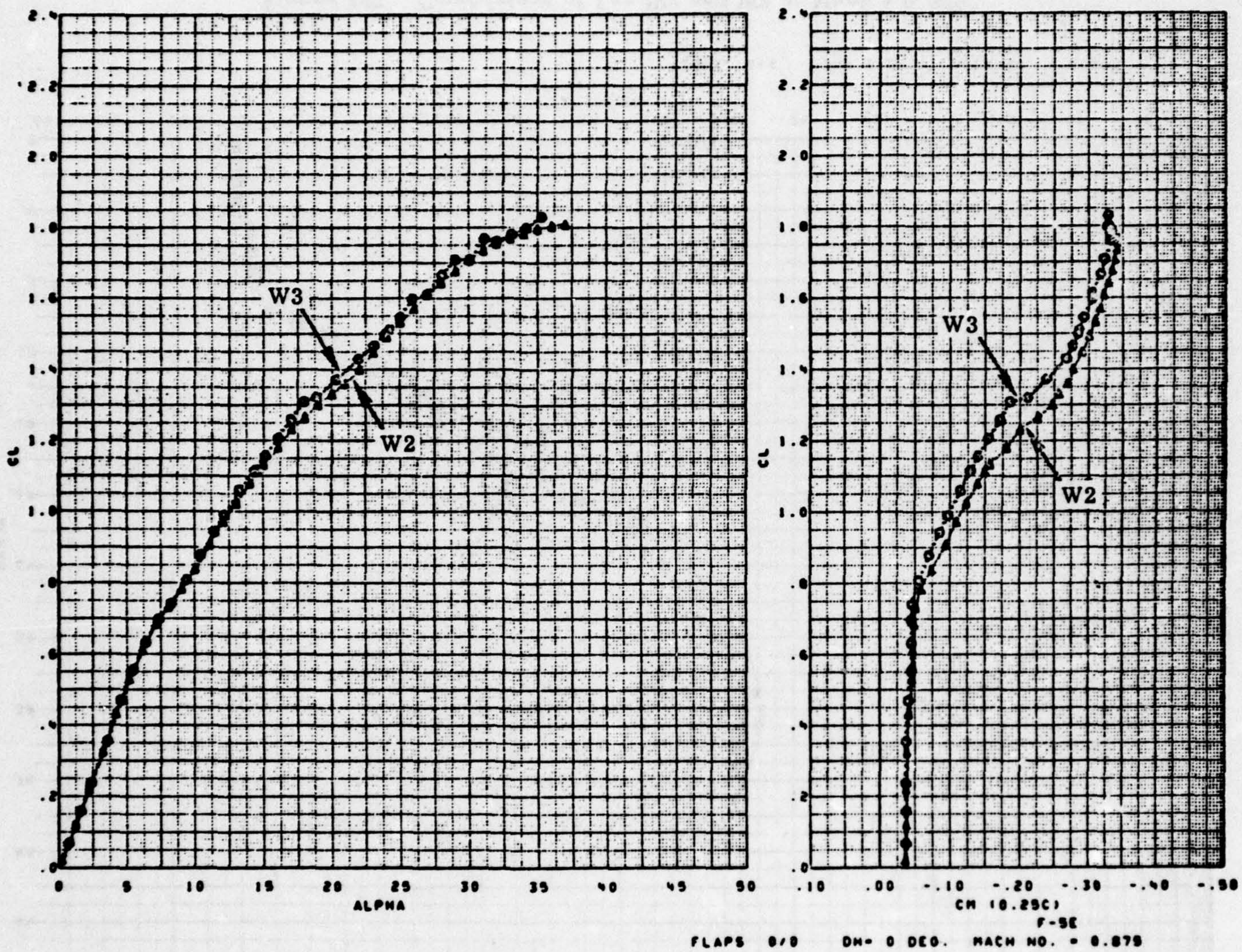


Figure 366. Comparison of Lex W2 and W3 at Mach = 0.875

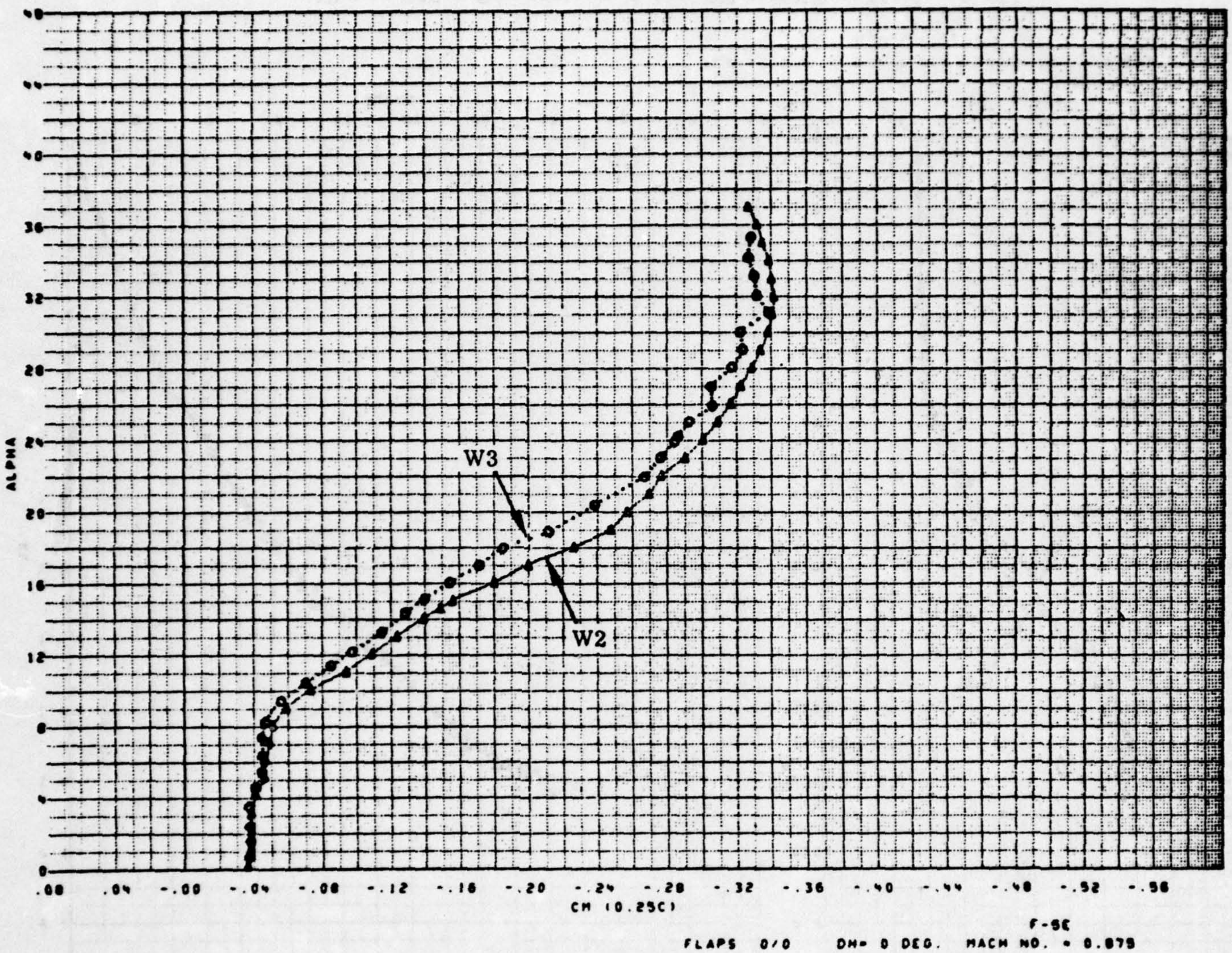


Figure 367. Comparison of Lex W2 and W3 at Mach = 0.875

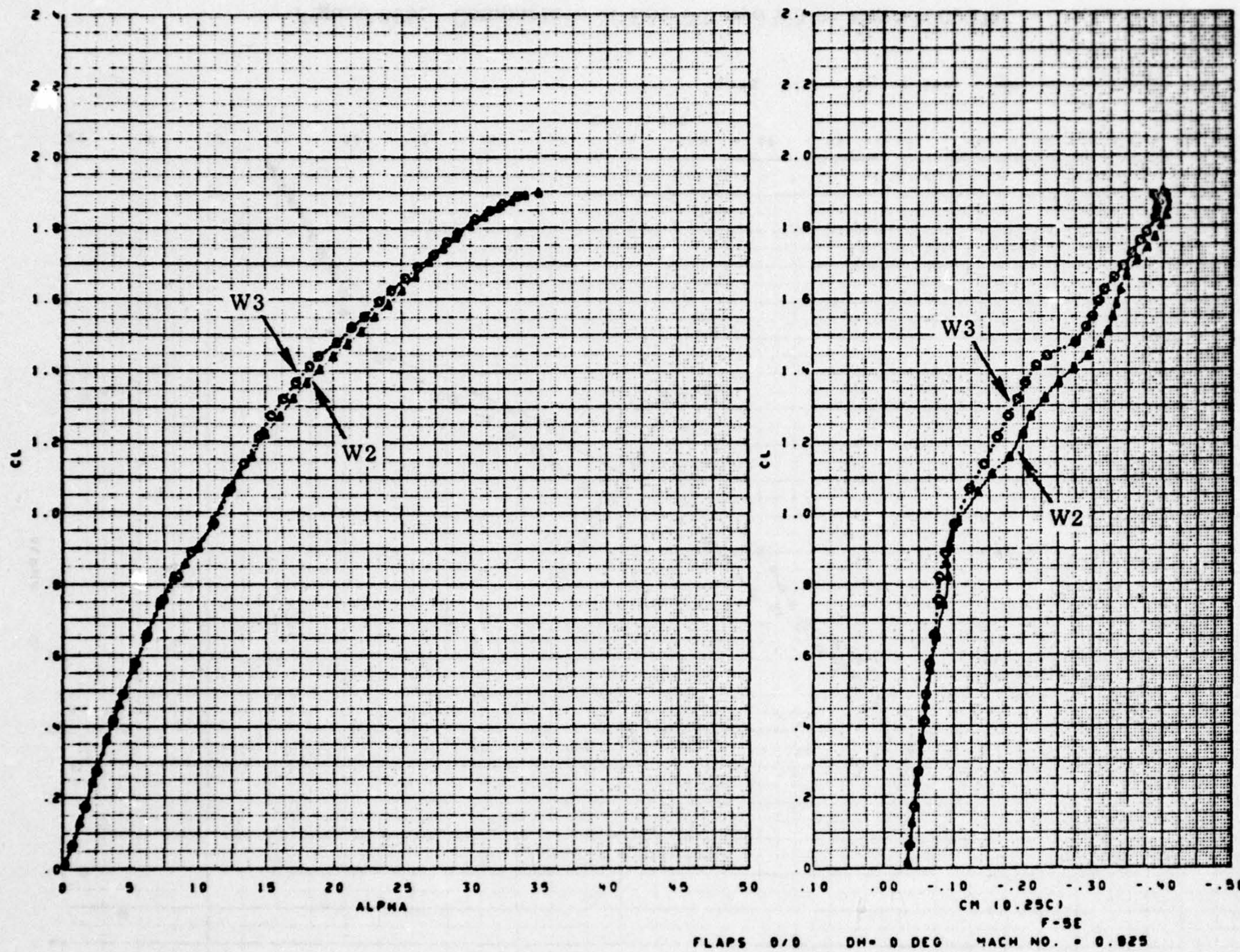


Figure 368. Comparison of Lex W2 and W3 at Mach = 0.925

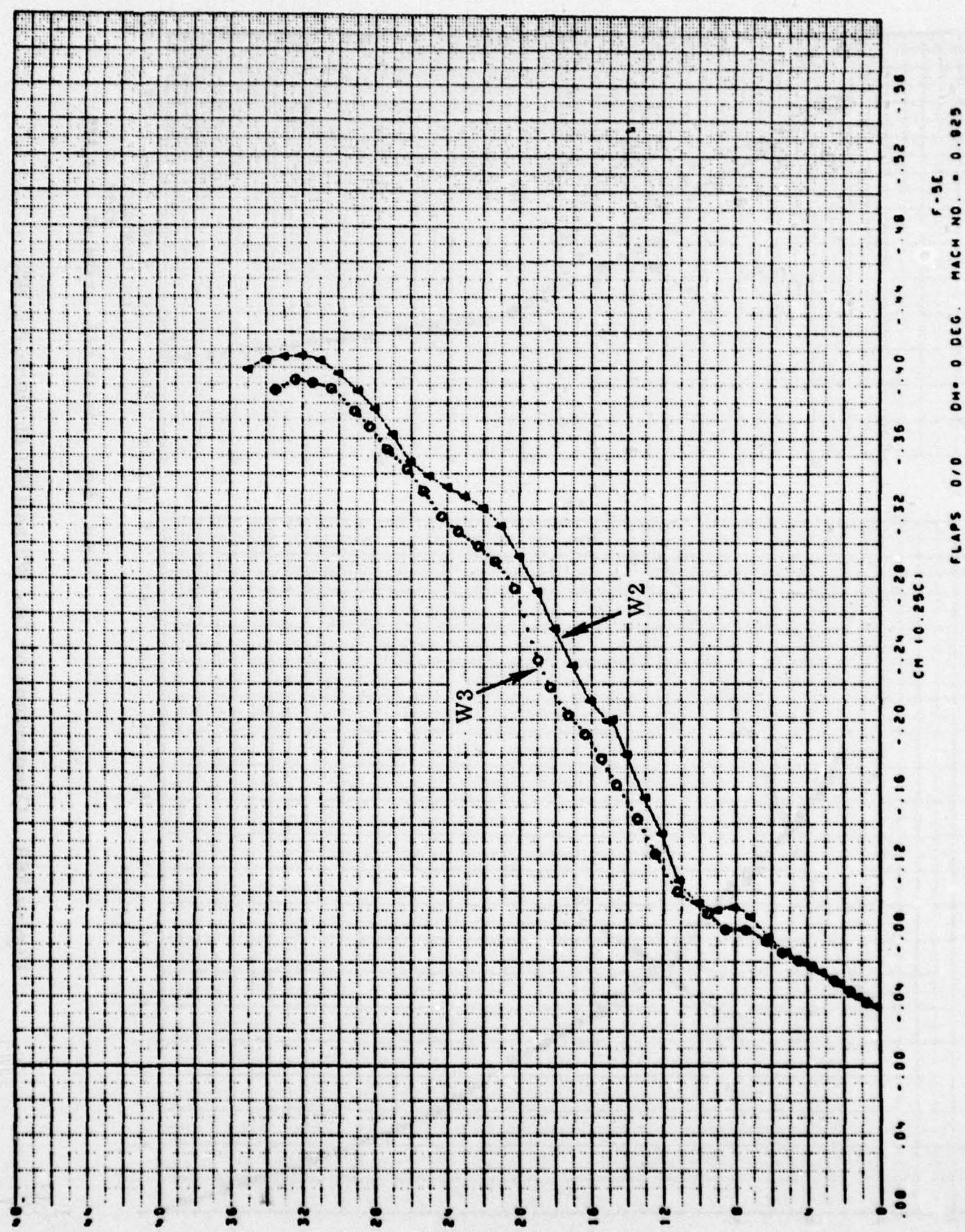


Figure 369. Comparison of Lex W2 and W3 at Mach = 0.925

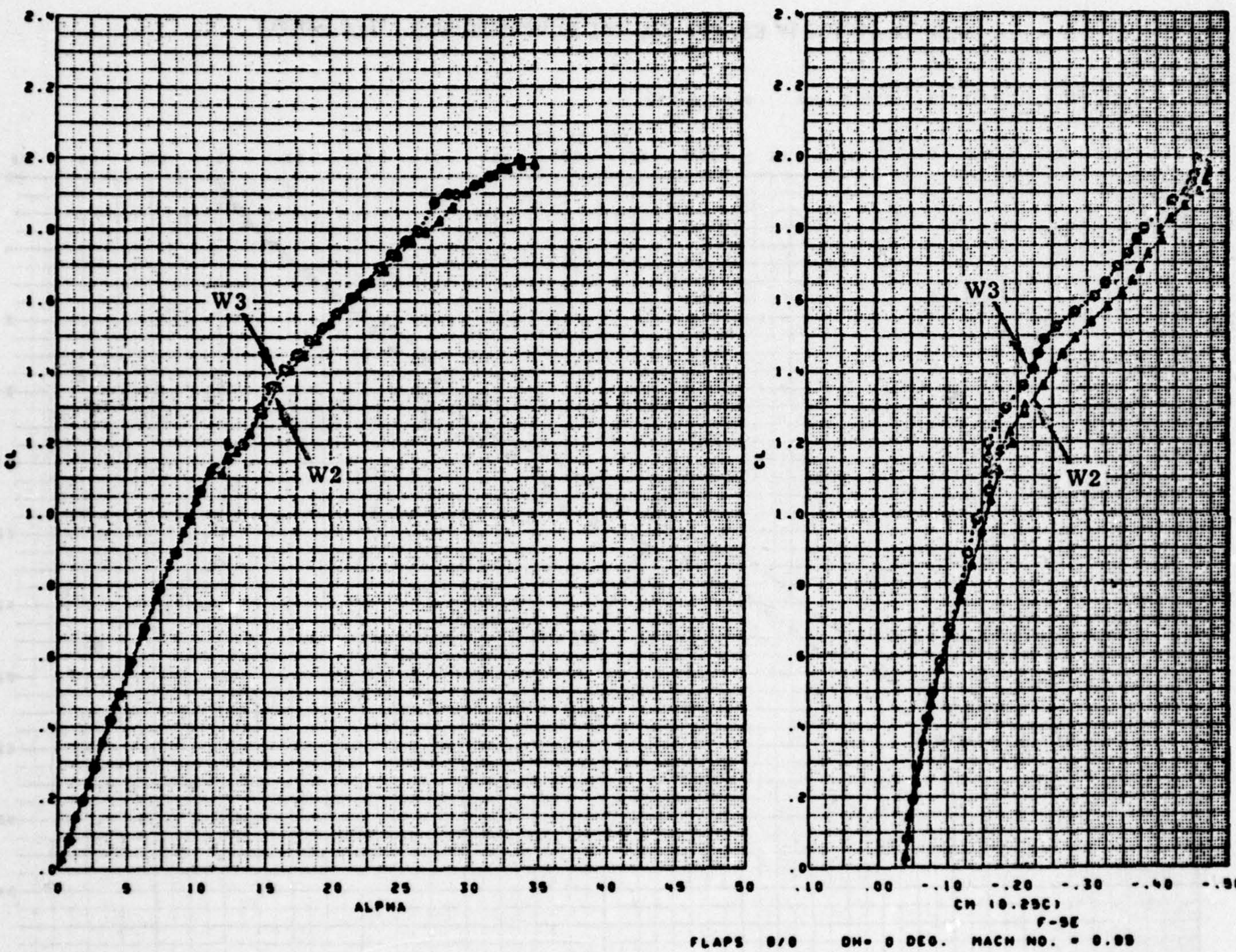


Figure 370. Comparison of Lex W2 and W3 at Mach = 0.95

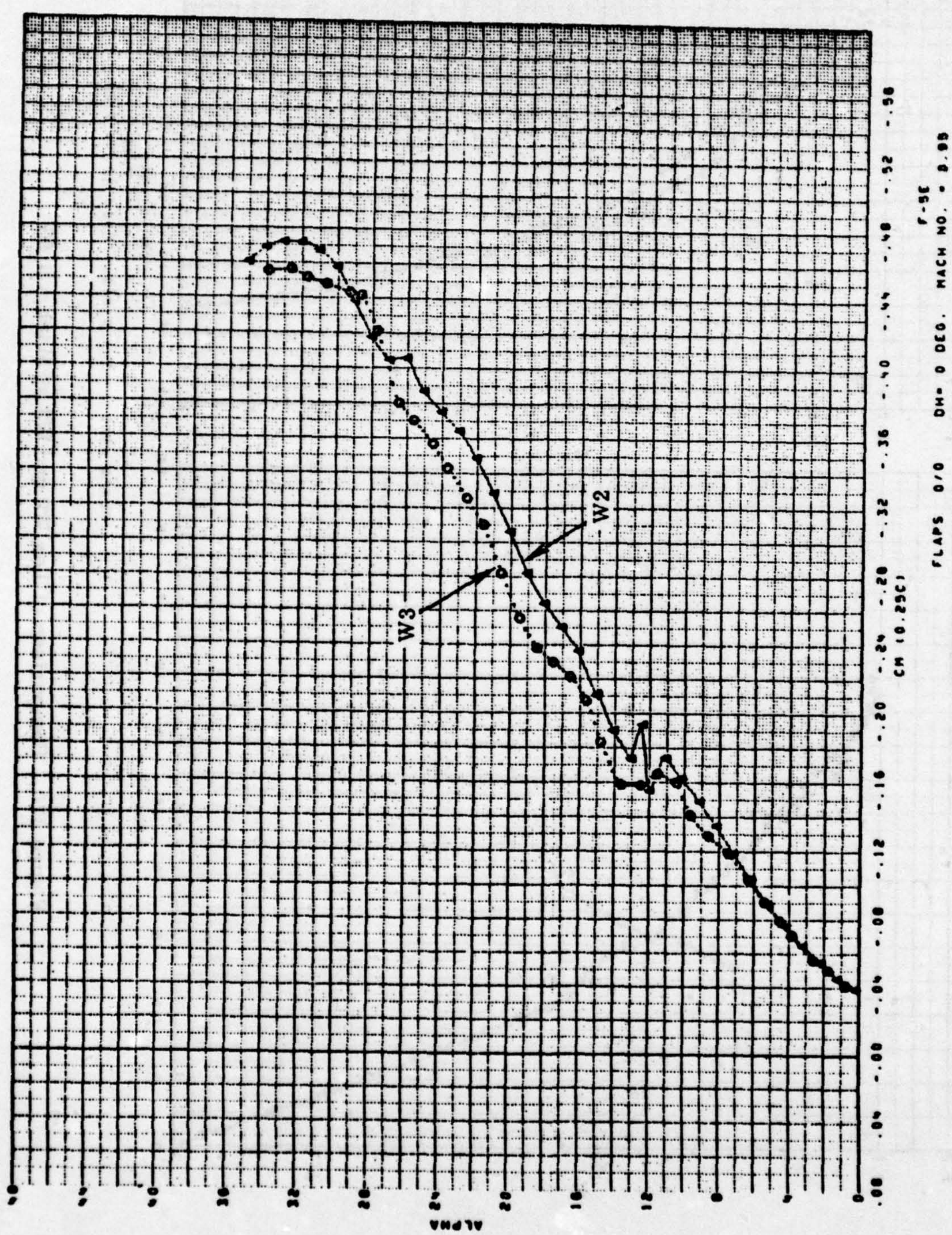


Figure 371. Comparison of Lex W2 and W3 at Mach = 0.95

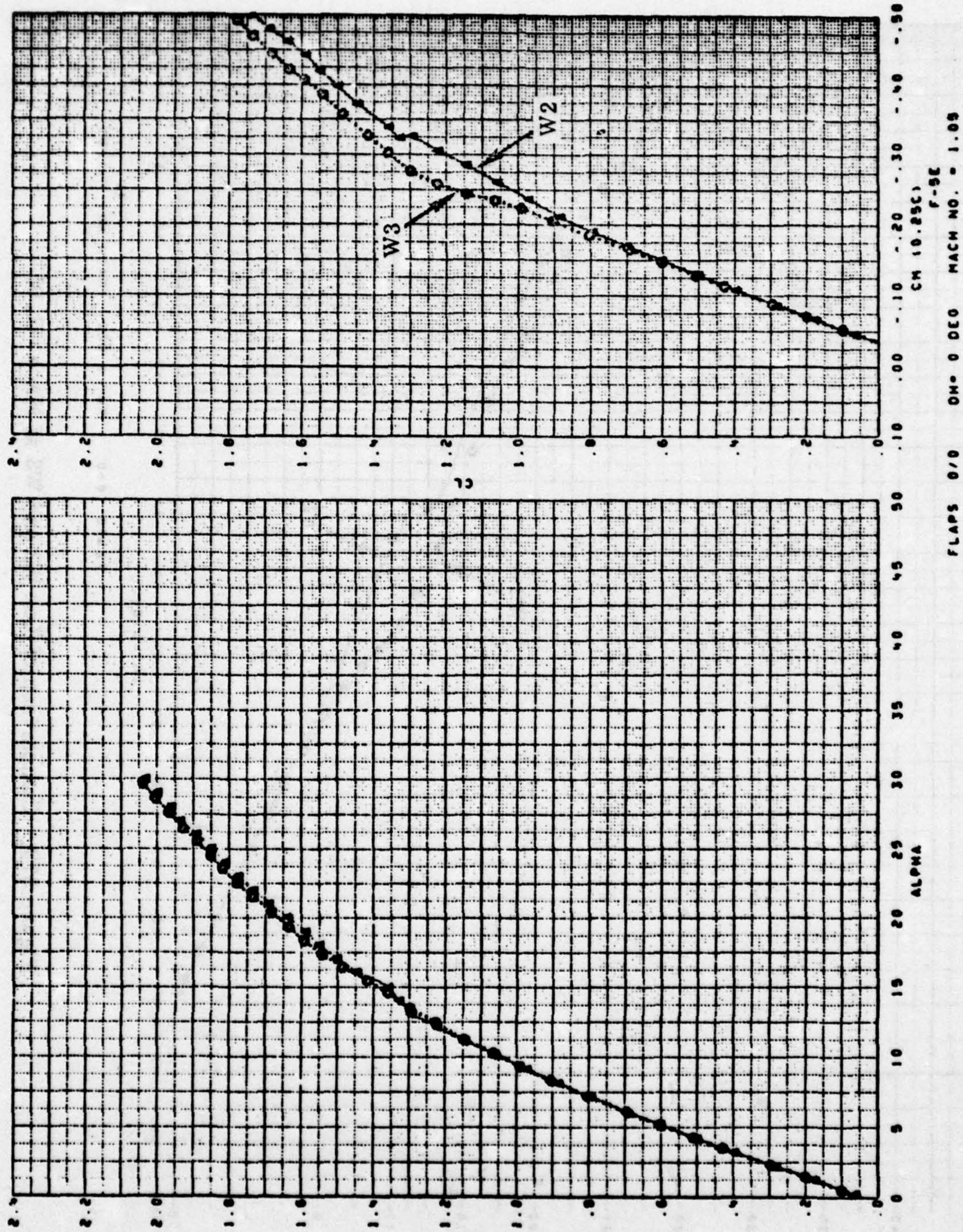


Figure 372. Comparison of Lex W2 and W3 at Mach = 1.05

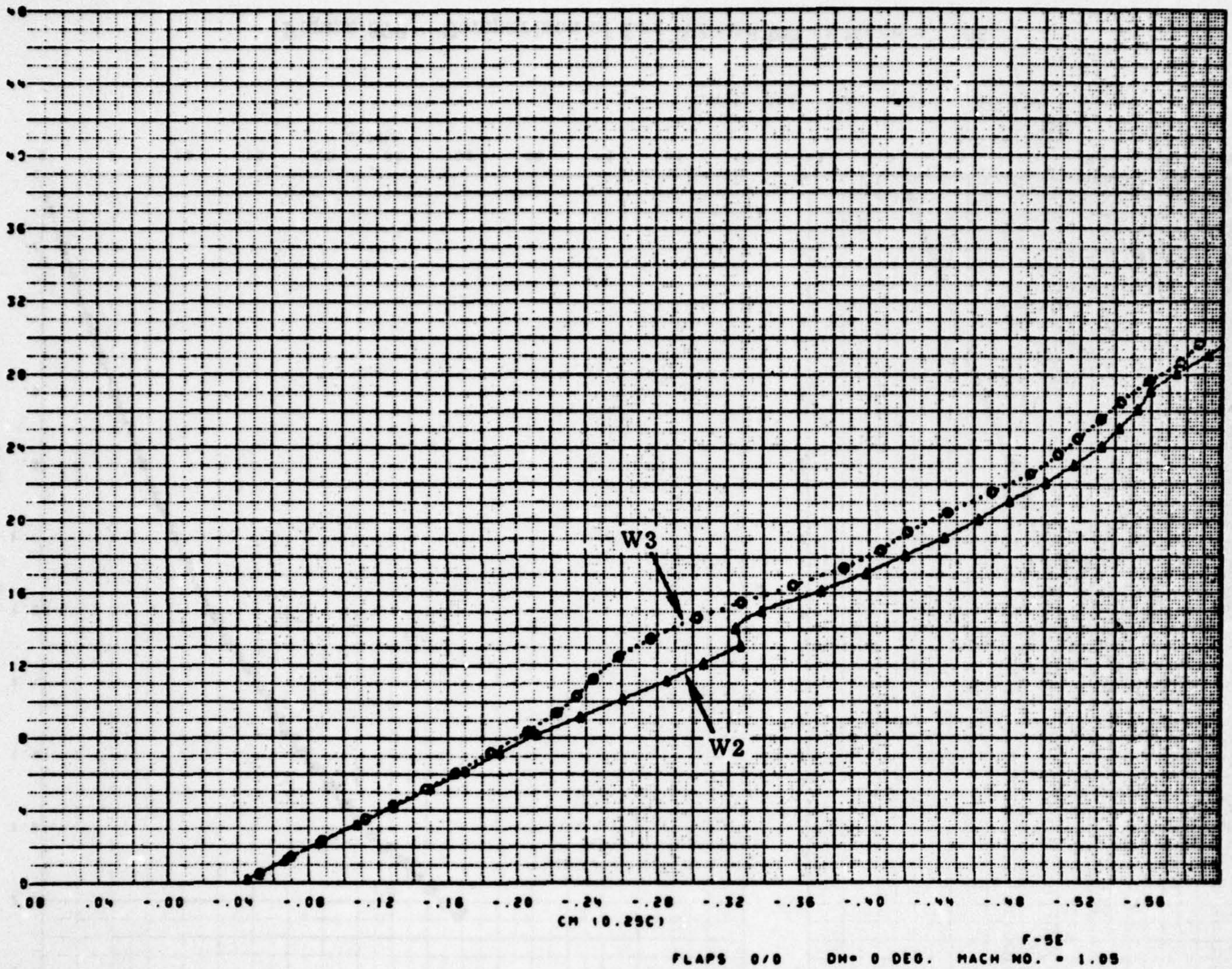


Figure 373. Comparison of Lex W2 and W3 at Mach = 1.05

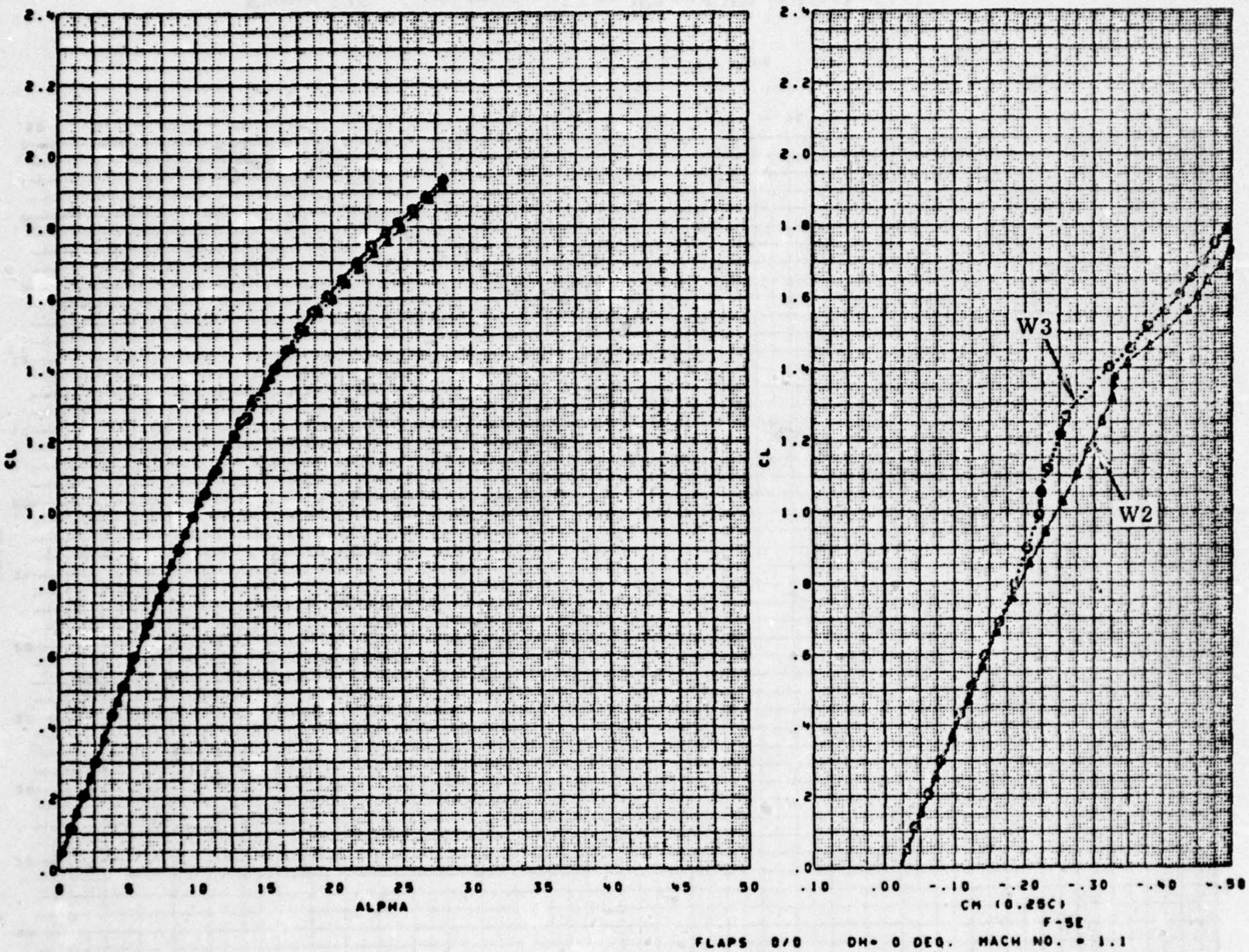


Figure 374. Comparison of Lex W2 and W3 at Mach = 1.1

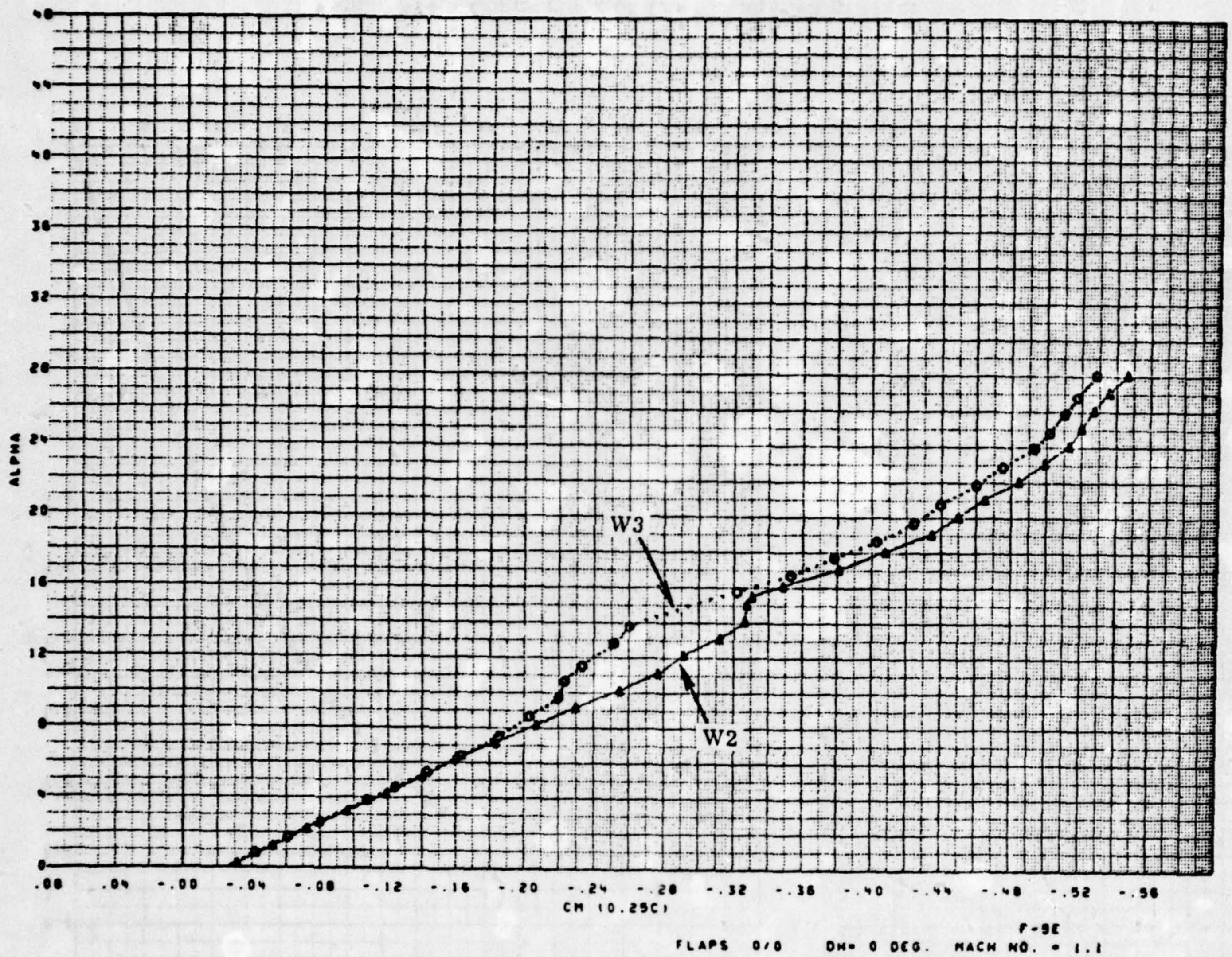


Figure 375. Comparison of Lex W2 and W3 at Mach = 1.1

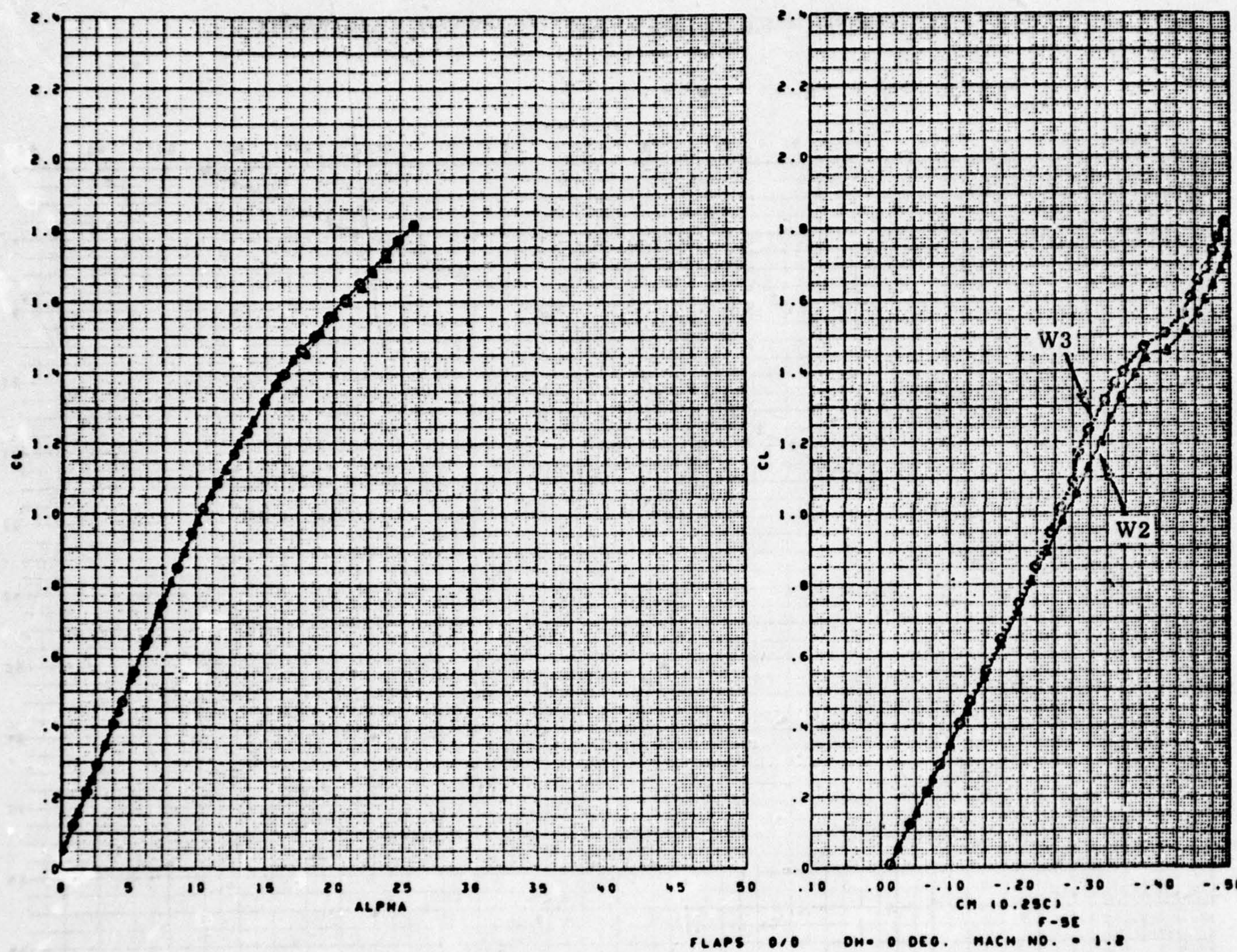


Figure 376. Comparison of Lex W2 and W3 at Mach = 1.2

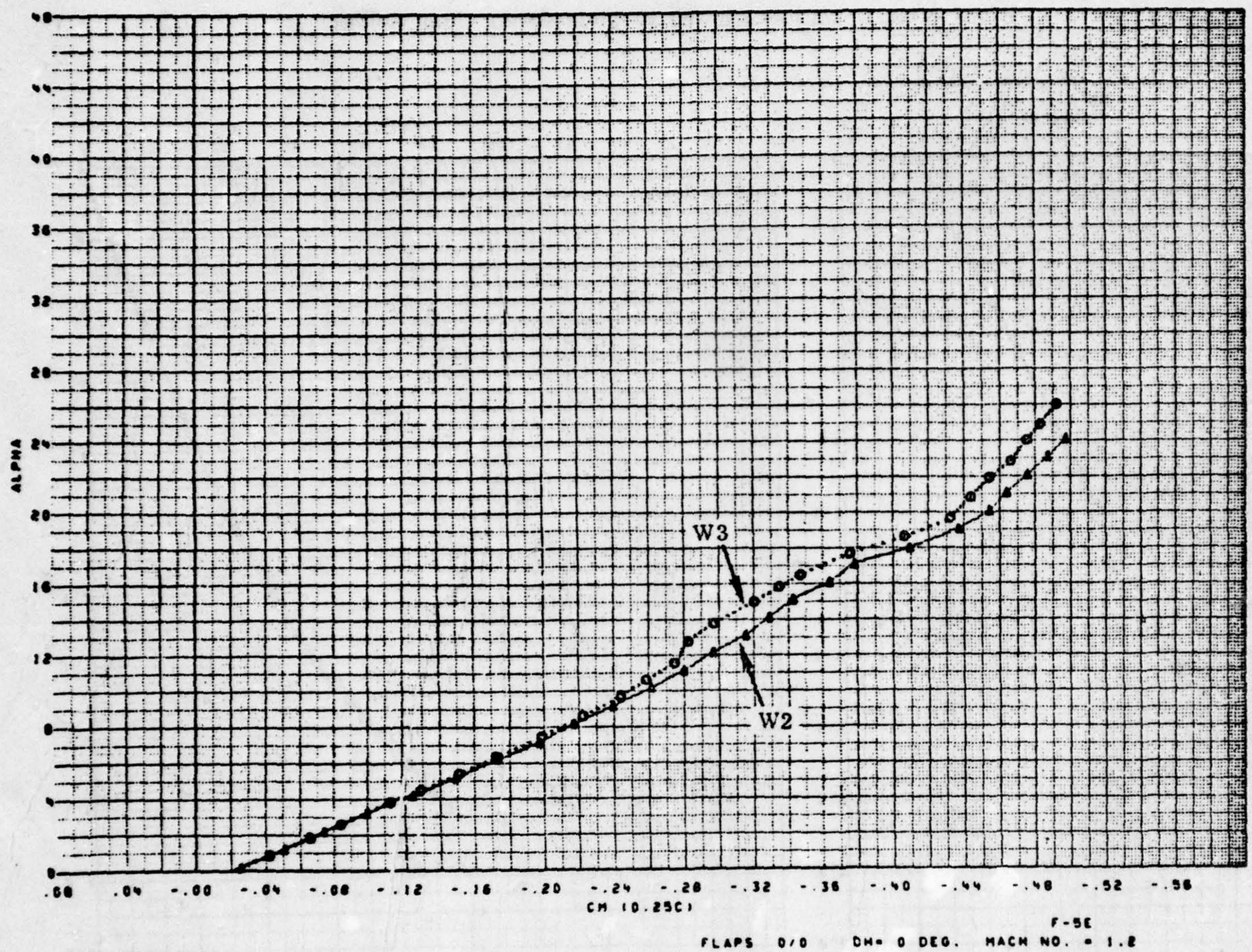


Figure 377. Comparison of Lex W2 and W3 at Mach = 1.2

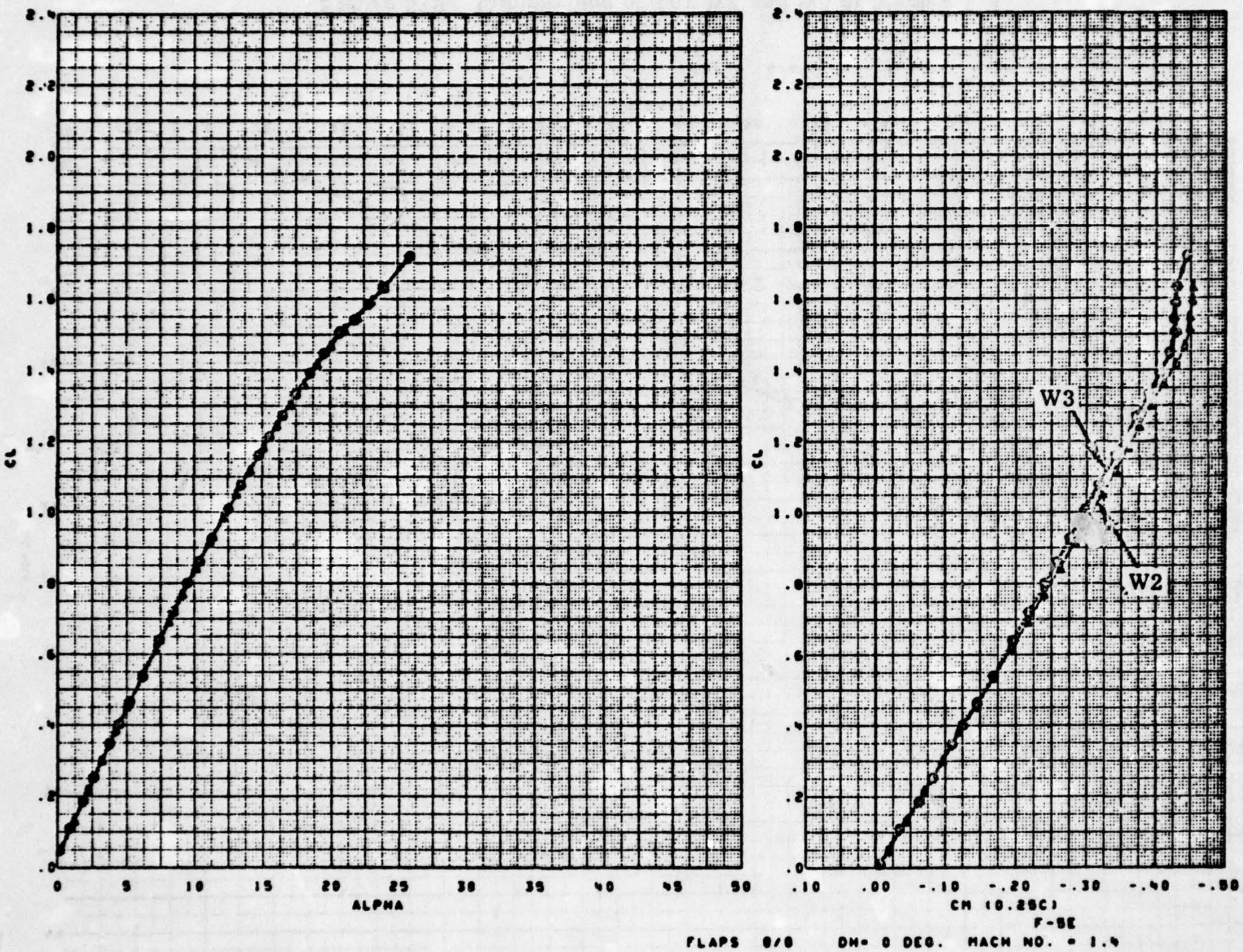


Figure 378. Comparison of Lex W2 and W3 at Mach = 1.4

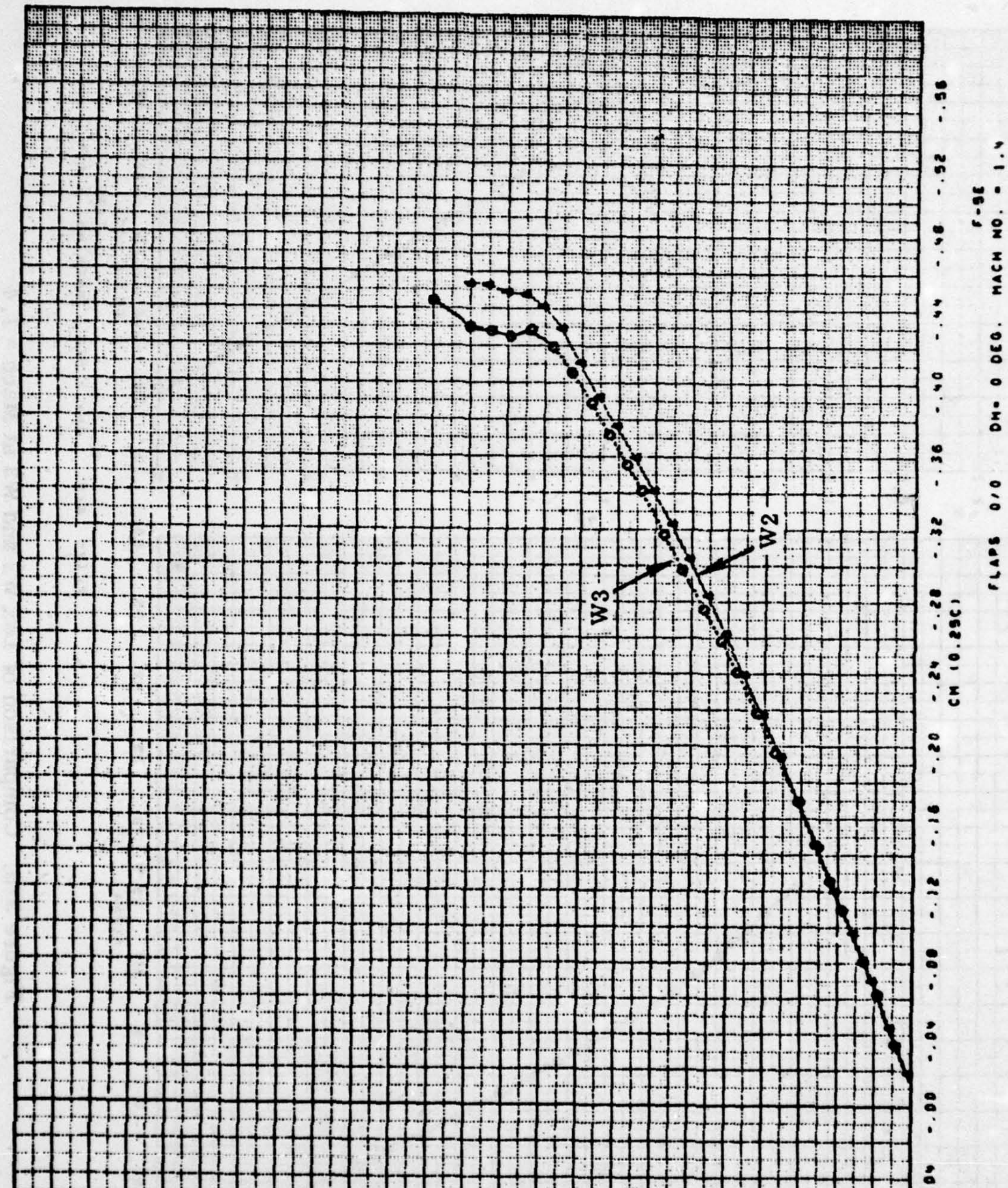


Figure 379. Comparison of Lex W2 and W3 at Mach = 1.4

AIRCRAFT **F-5E** REFERENCE **57**

TEST REPORT

NOR 72-39 Data Report of a Supersonic Wind Tunnel Test of a One-Tenth Scale F-5E Force Model

A.D. Crandell

REPORT SUMMARY

This report presents the data from a supersonic wind tunnel test from a one-tenth scale model of the F-5 E airplane. The test was conducted during the period from 28 April to 4 May 1971.

The objectives of the test were:

1. The effect of Mach numbers on model characteristics
2. Horizontal tail effectiveness
3. Effect of speedbrakes
4. Aileron effectiveness
5. Effect of rudder deflection
6. Horizontal tail loads

TEST CONDITIONS

Mach No. = 1.55 - 2.0

R.N./Foot = 1.8×10^6

A.O.A. Range = 0 to 20°

Sideslip Range = 0 to 6°

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 208.

CONFIGURATION CHANGES

Sketches of LEX planform configuration changes applicable to this study are shown in Figure 359.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figures 380 through 383 compare lift and pitching moment data of LEX planforms W2 and W3 for Mach Numbers 1.60 and 1.70. Data effects for objectives 2 through 6 listed above was not considered pertinent.

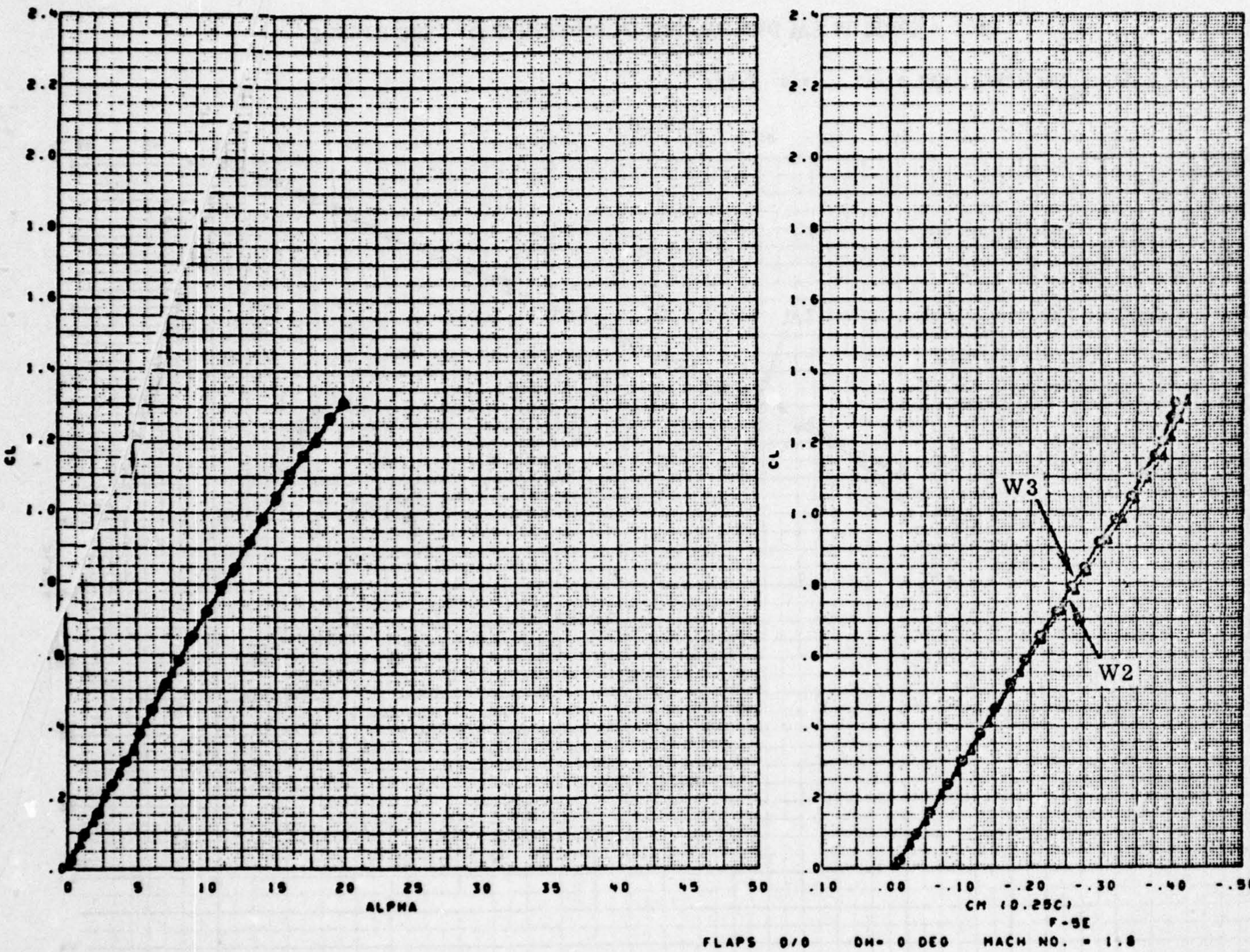


Figure 380. Comparison of Lex W2 and W3 at Mach = 1.6

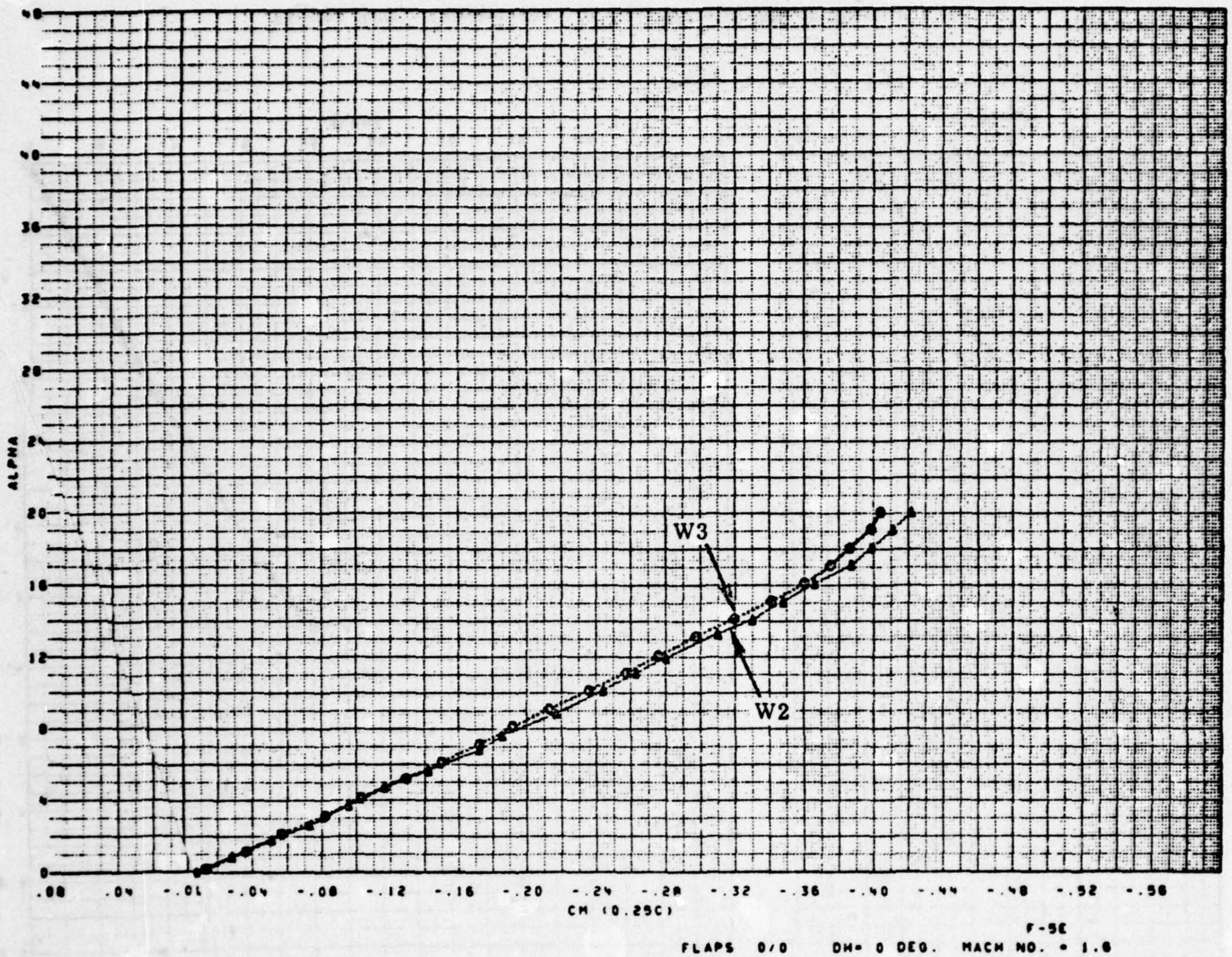


Figure 381. Comparison of Lex W2 and W3 at Mach = 1.6

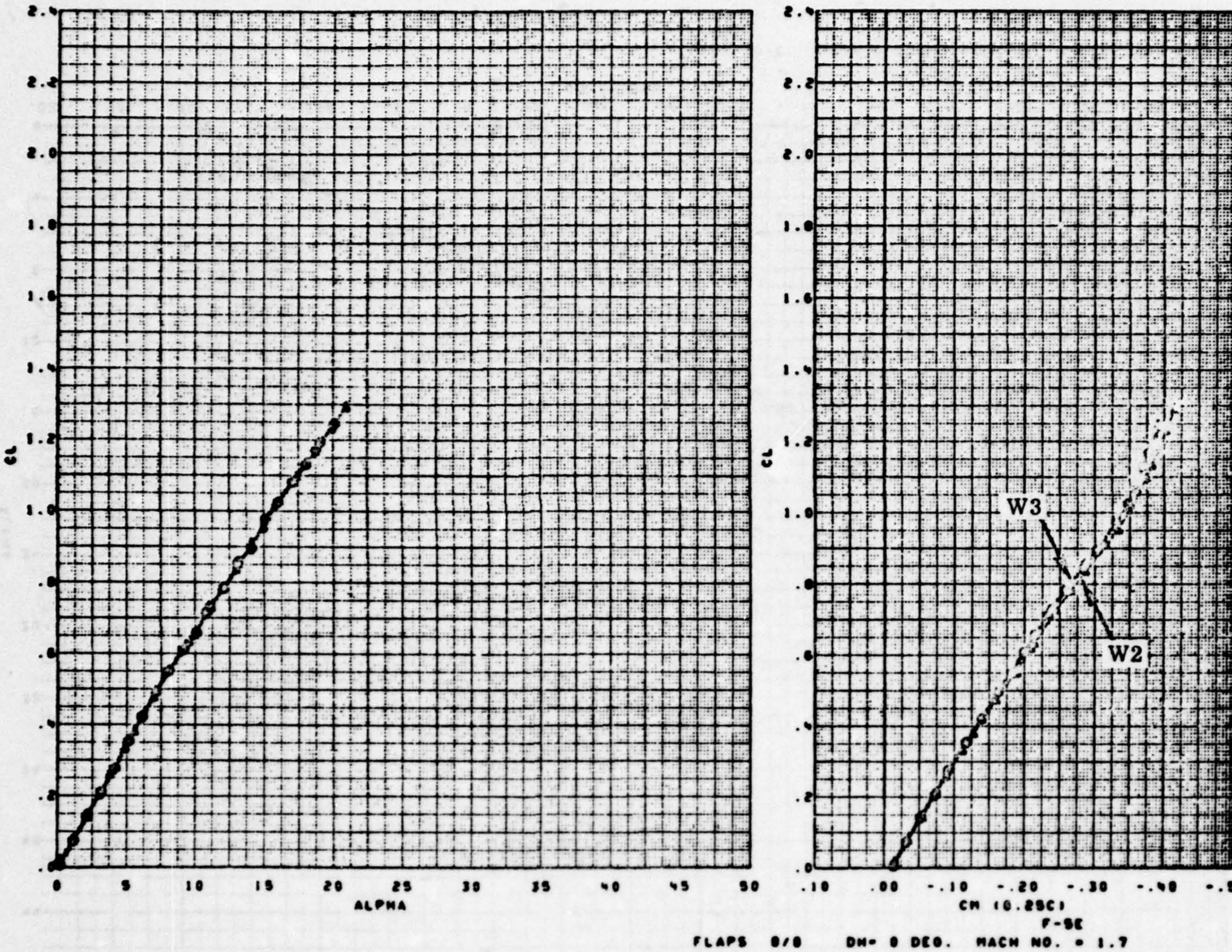


Figure 382. Comparison of Lex W2 and W3 at Mach = 1.7

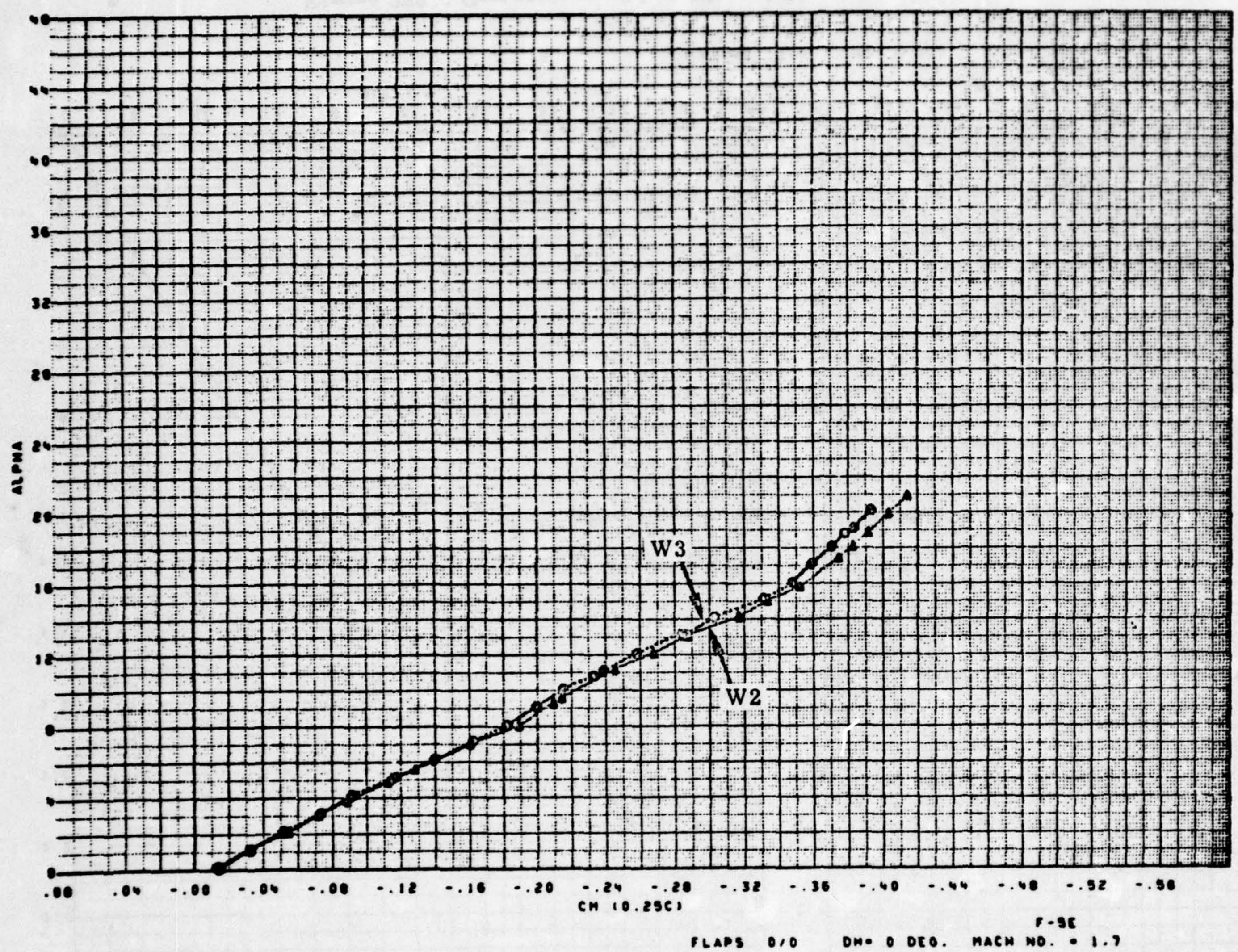


Figure 383. Comparison of Lex W2 and W3 at Mach = 1.7

AIRCRAFT	F-5E/F	REFERENCE	58

TEST REPORT

Transonic Wind Tunnel Tests of 1 and 2 Place Configurations of a 0.10 Scale F-5E Airplane with External Stores

N. A. Struzynski   Calspan Report AA-4013-W-5

REPORT SUMMARY

This report presents force and moment data from aerodynamic tests on a 0.10 scale model of the Northrop F-5E/F aircraft in the Calspan Corporation 8-Foot Transonic Wind Tunnel during July, 1973. The F-5 is a full span model and was sting mounted on the Calspan TASK MK XIX-B internal strain gage balance. Northrop balances were used to measure loads on two external stores and the horizontal tail.

The tests were performed in order to obtain airplane stability and drag data, horizontal tail panel loads, and stability data on two types of external stores.

TEST CONDITIONS

Mach No.	=	0.6 - 1.2
R.N./Foot	=	2.0×10^6
A.O.A. Range	=	-4^o to 36^o
Sideslip Range	=	0^o to -10^o

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 208.

CONFIGURATION CHANGES

Sketches of F-5E and F-5F nose geometry configurations are shown in Figure 208 and Figure 222.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figure 384 through 399 compare lift, pitching moment and lateral/directional data at zero sideslip of the F-5E and F-5F for Mach Numbers 0.6, 0.8, 0.875, 0.925, 0.95, 1.05, 1.10 and 1.20.

Figures 400 through 407 compare lateral/directional stability data of the F-5E and F-5F for the same range of Mach Numbers.

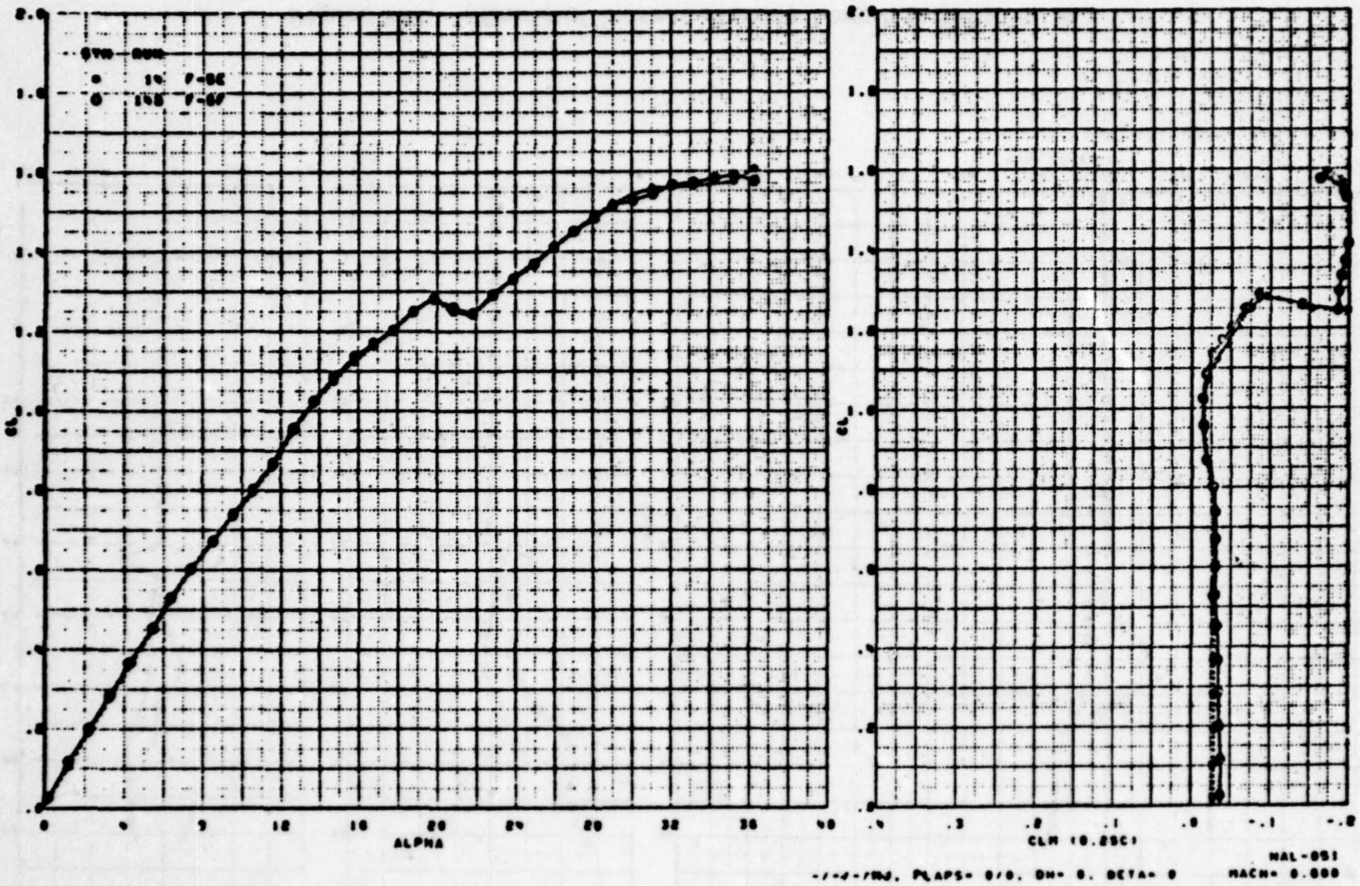


Figure 384. Effects of Increased Nose Length in Pitch at M = 0.6

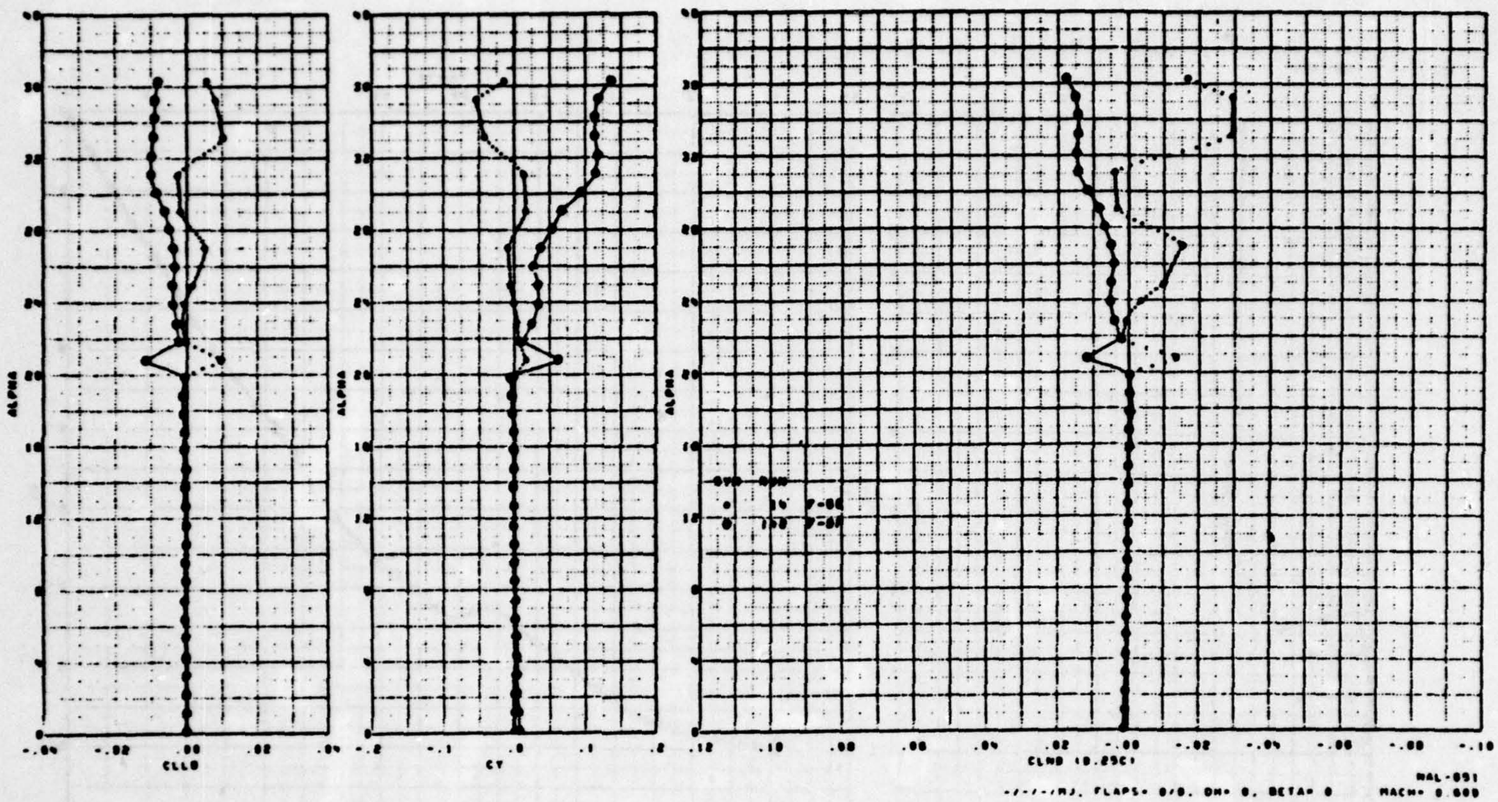


Figure 385. Effects of Increased Nose Length in Pitch at M = 0.6

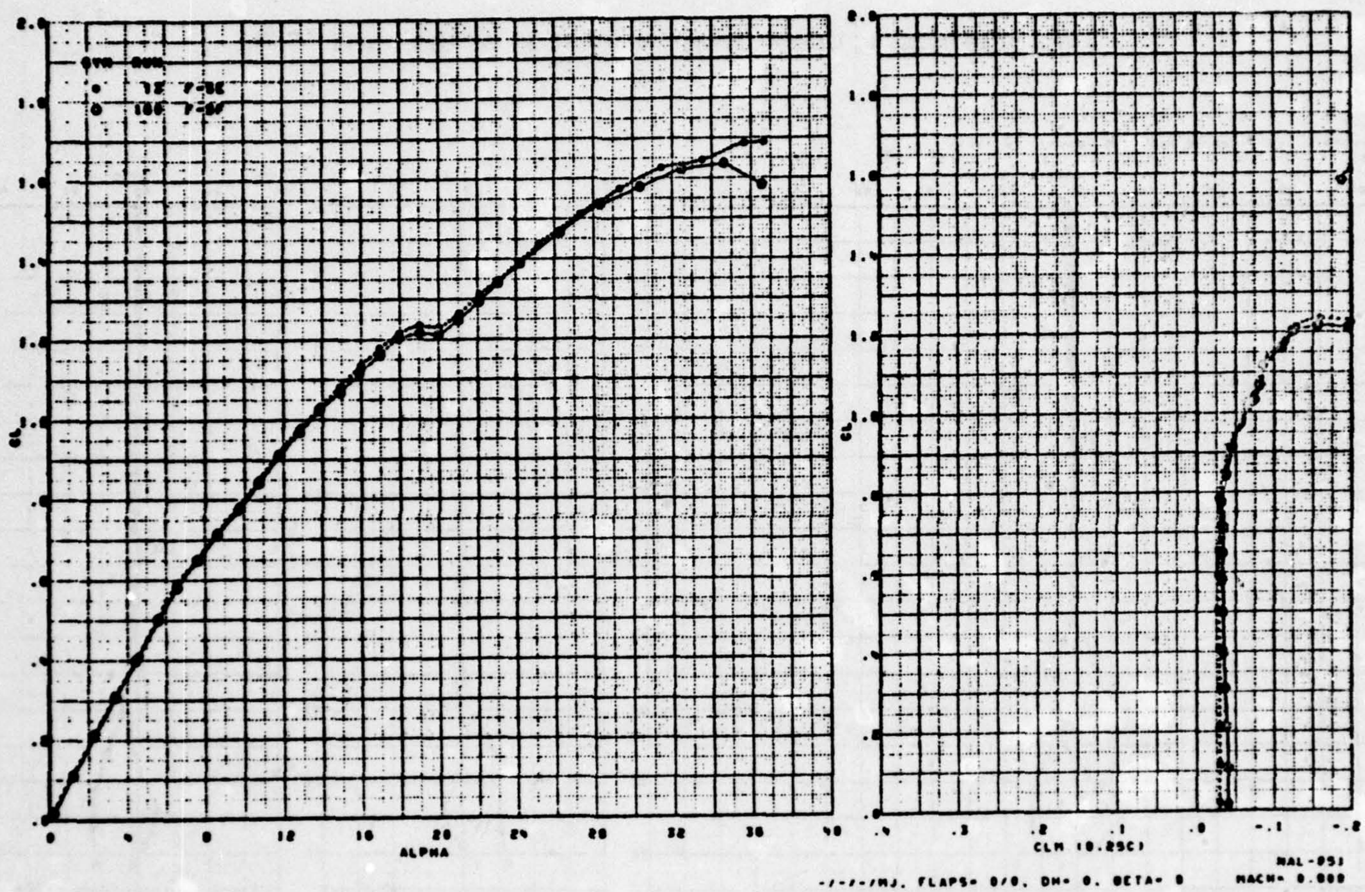


Figure 386. Effect of Increased Nose Length in Pitch at M = 0.8

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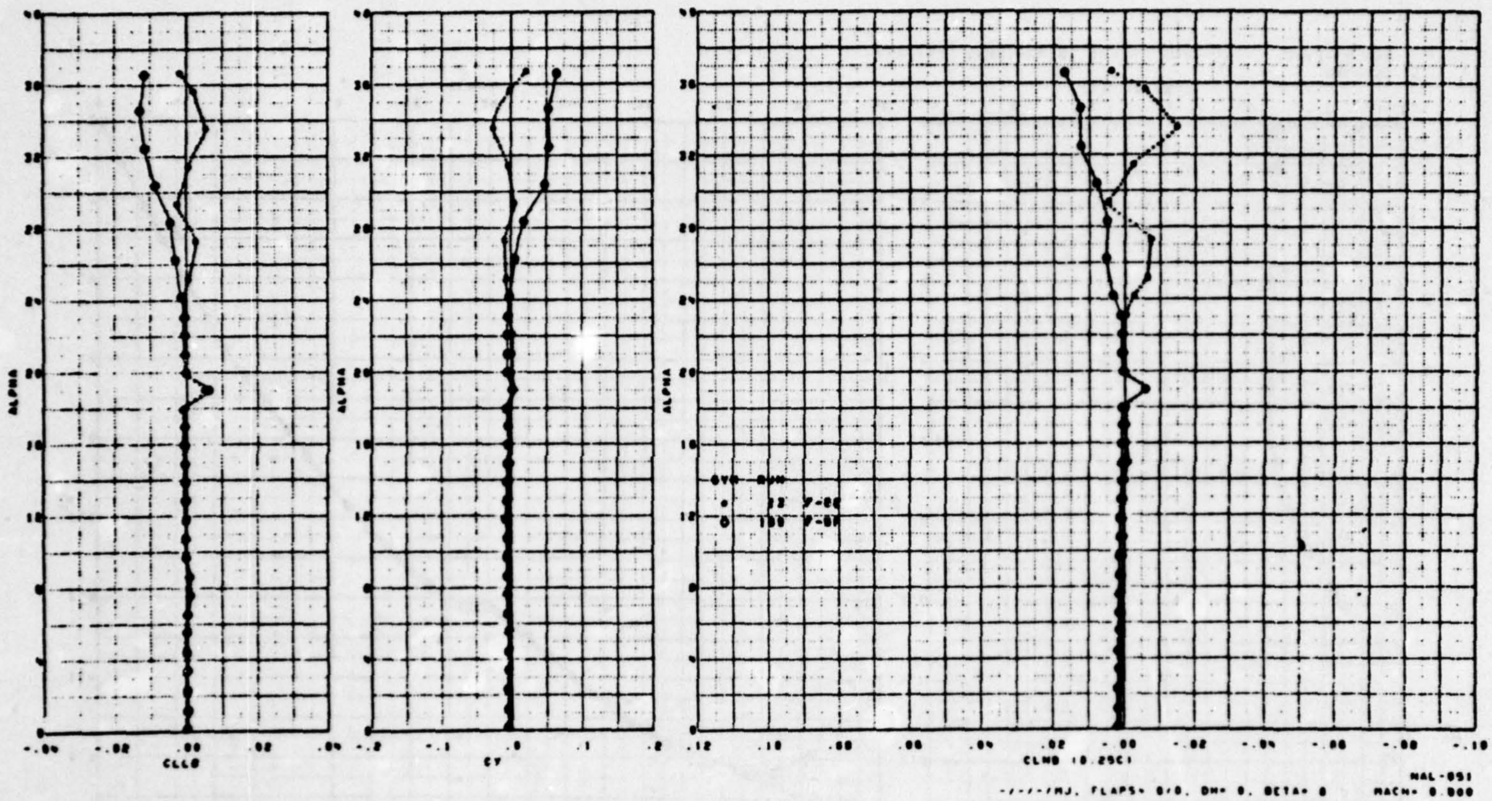


Figure 387. Effects of Increased Nose Length in Pitch at M = 0.8

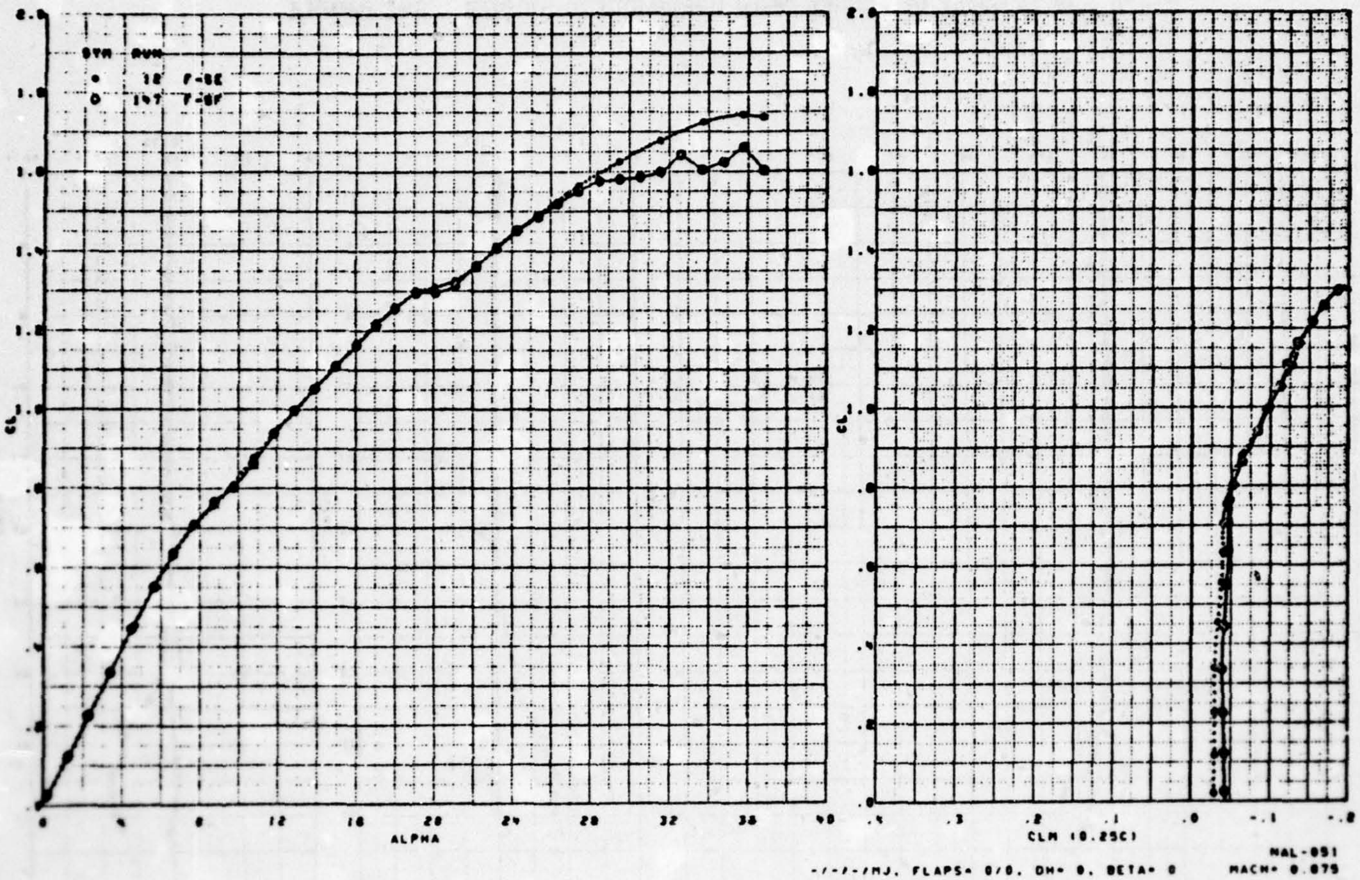


Figure 388. Effects of Increased Nose Length in Pitch at M = 0.875

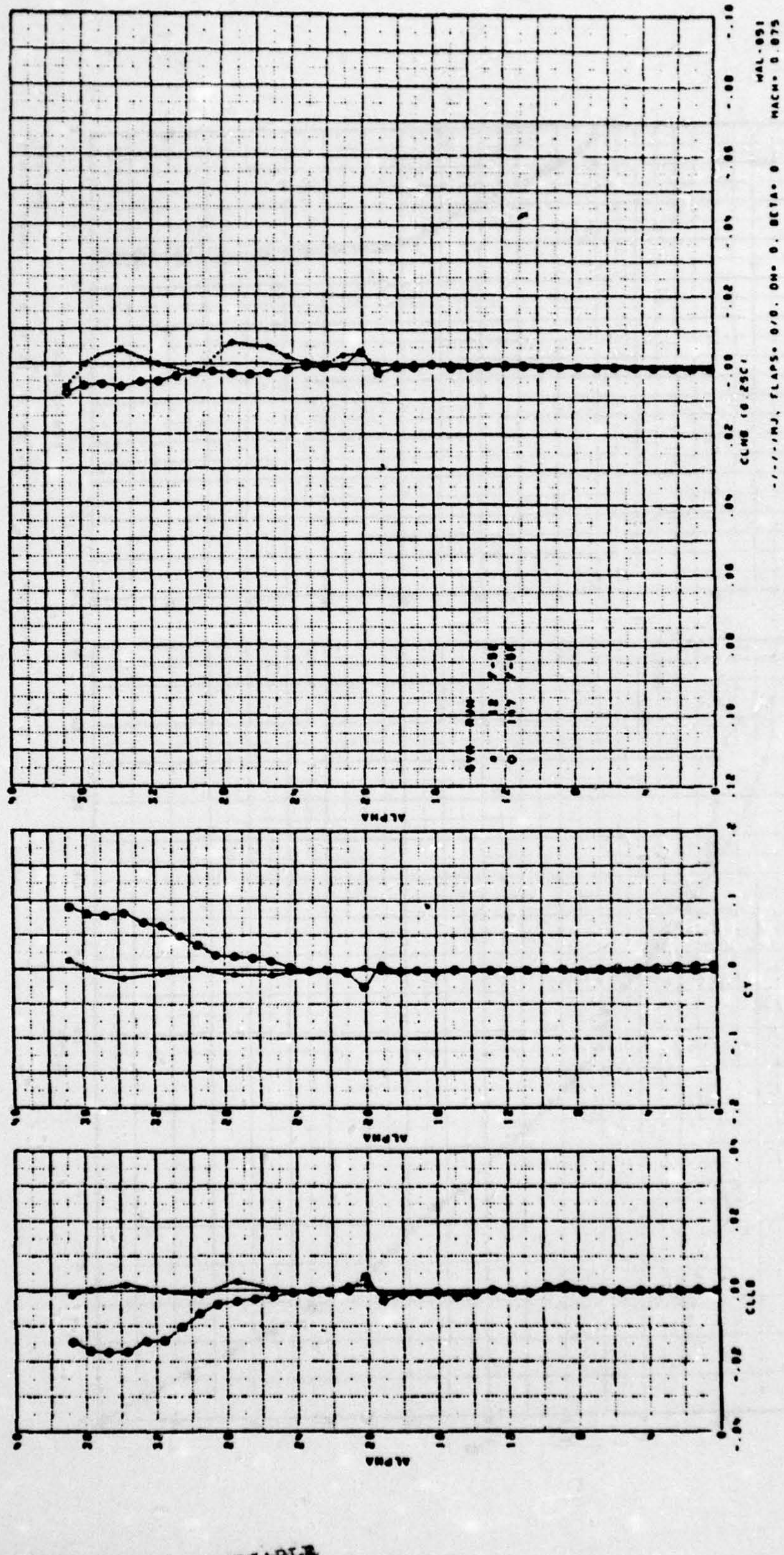


Figure 389. Effects of Increased Nose Length in Pitch at M = 0.875

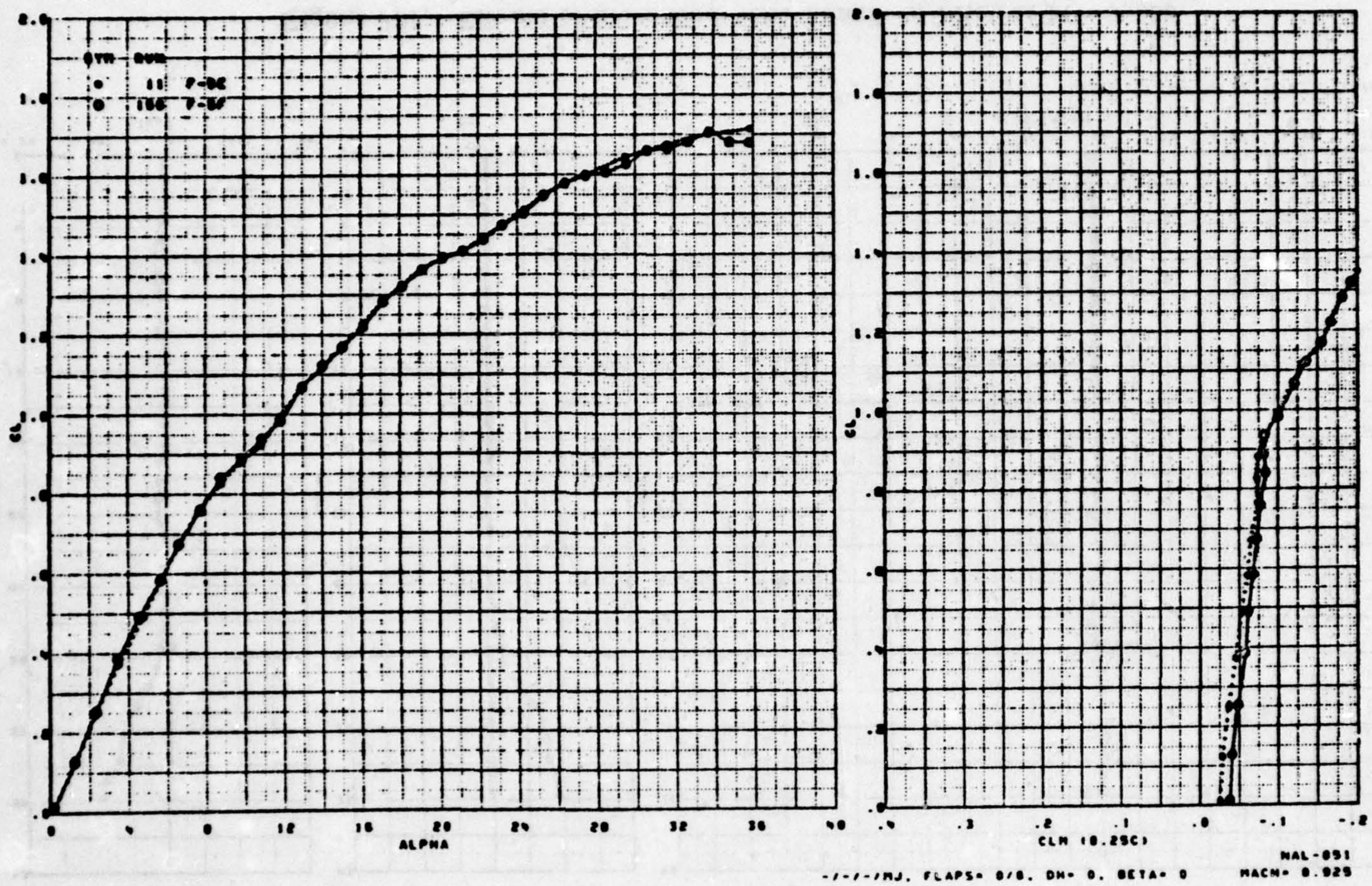


Figure 390. Effects of Increased Nose Length in Pitch at M = 0.925

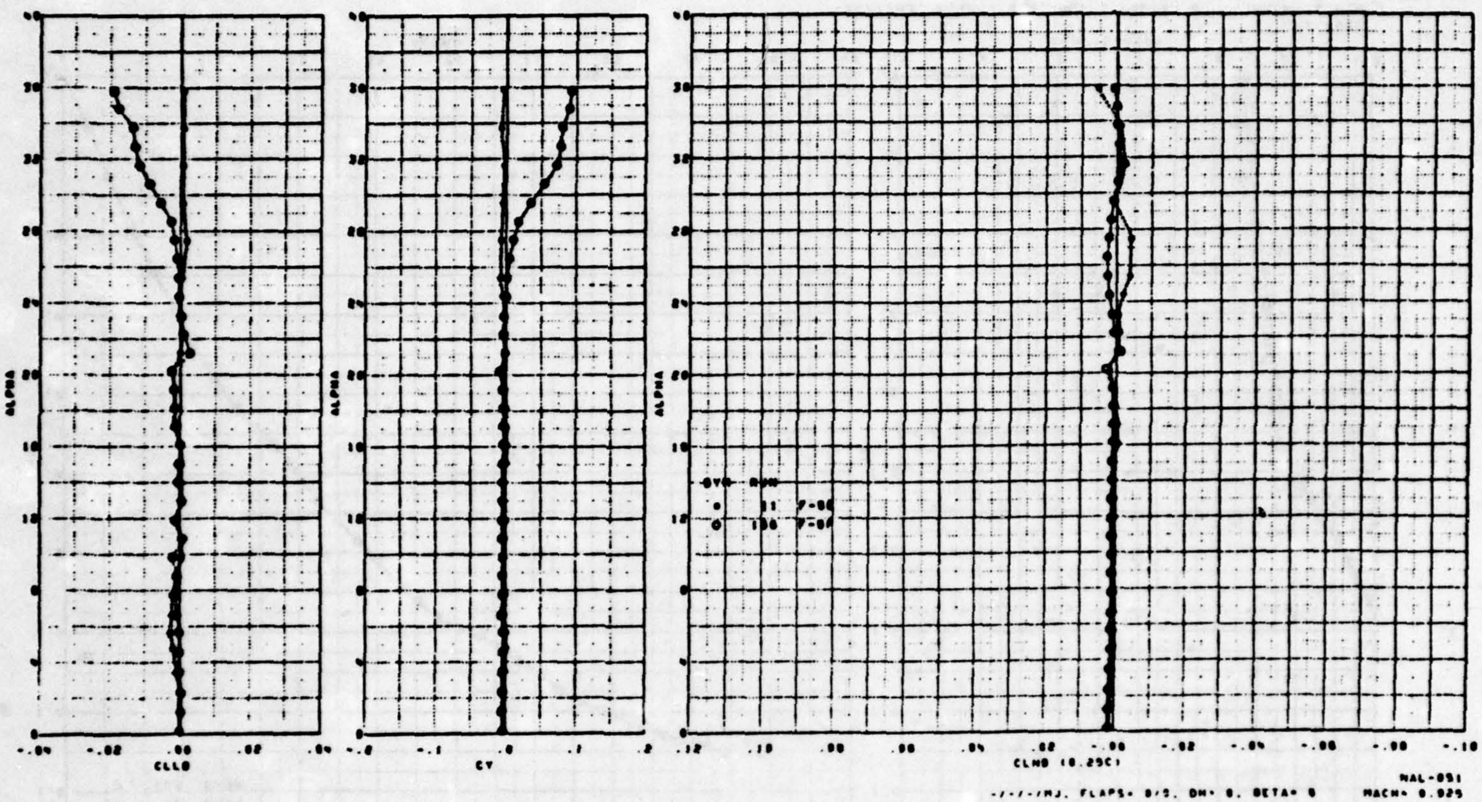


Figure 391. Effects of Increased Nose Length in Pitch at M = 0.925

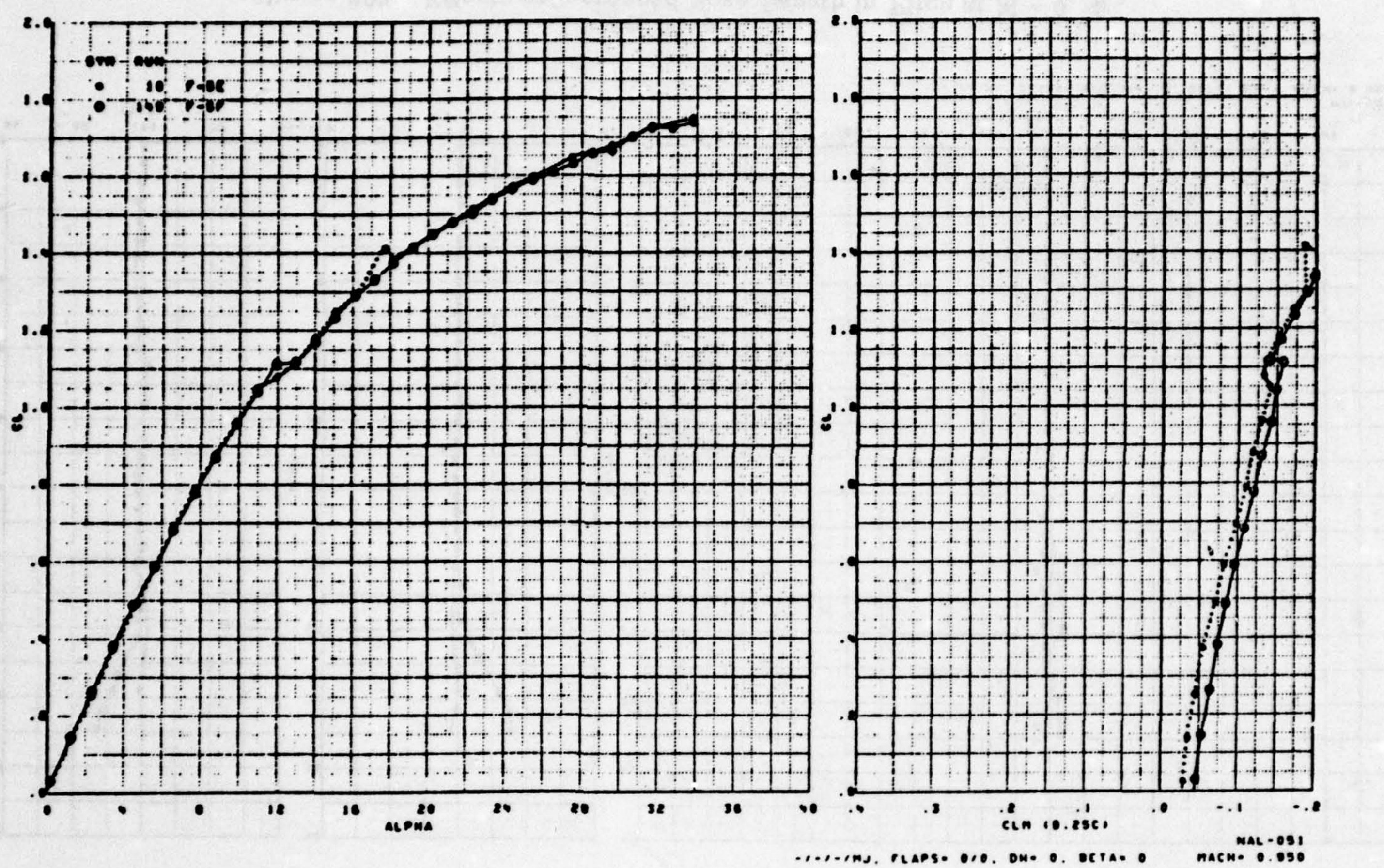


Figure 392. Effects of Increased Nose Length in Pitch at M = 0.95

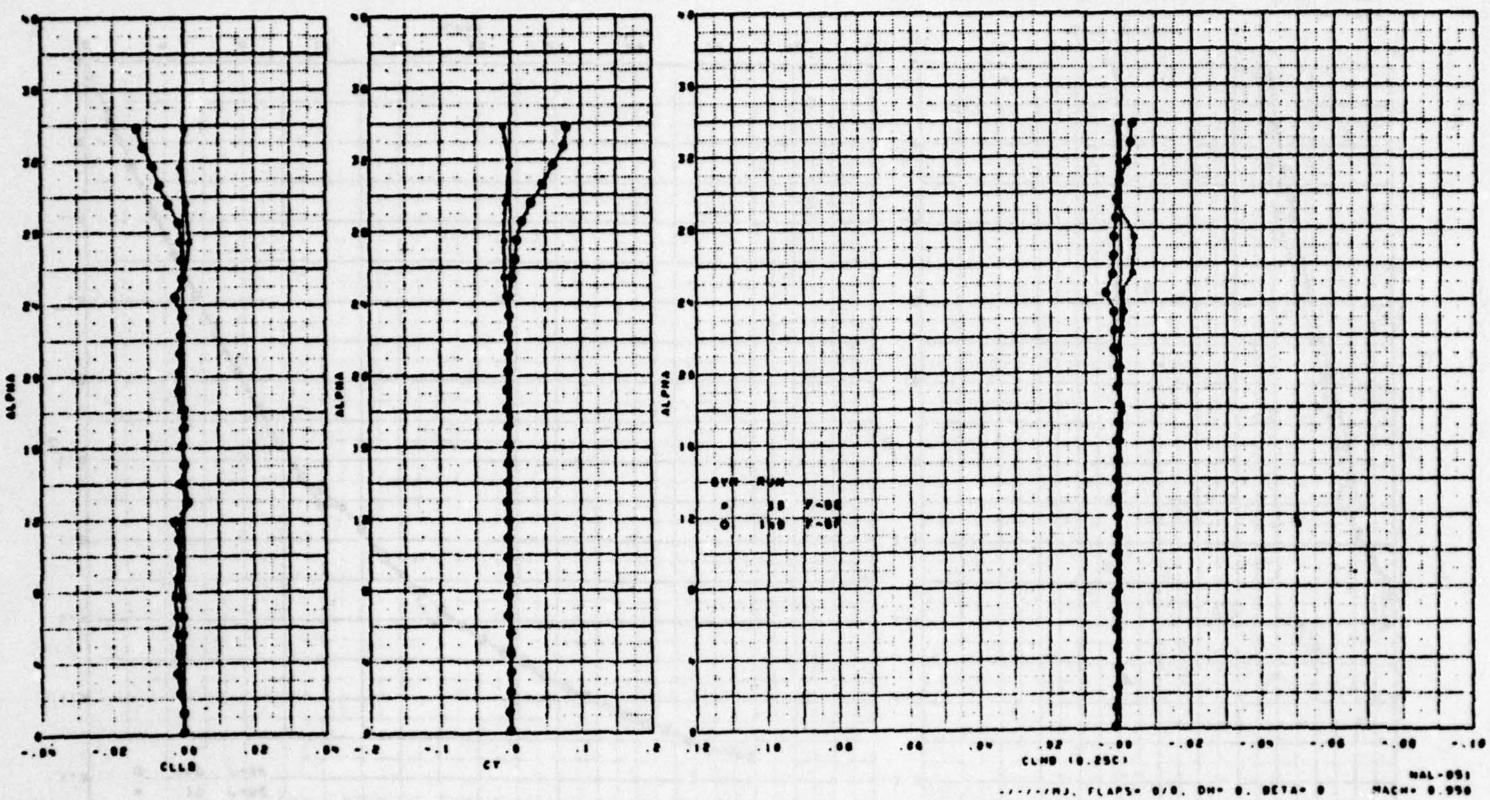


Figure 393. Effects of Increased Nose Length in Pitch at M = 0.95

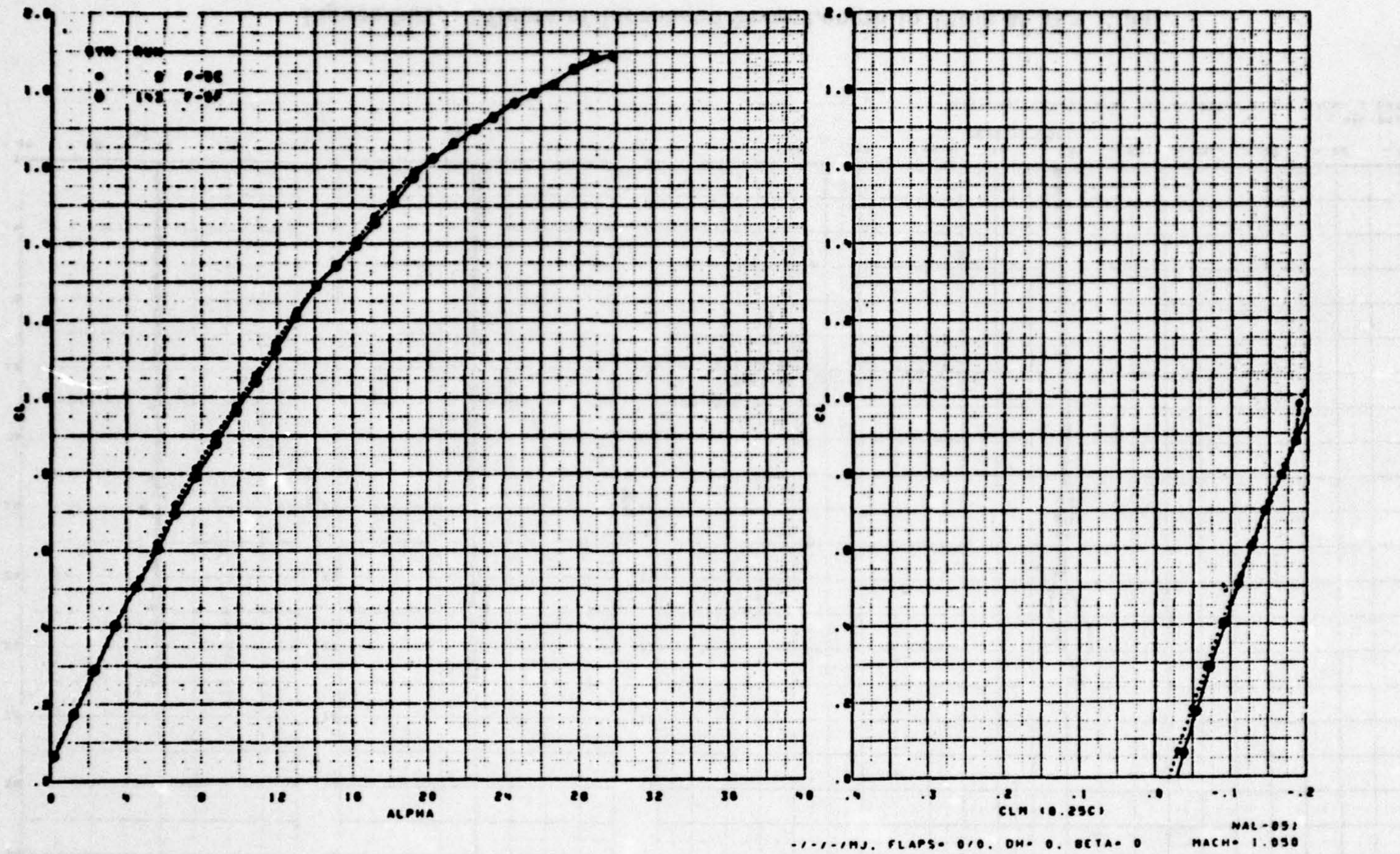


Figure 394. Effects of Increased Nose Length in Pitch at M = 1.05

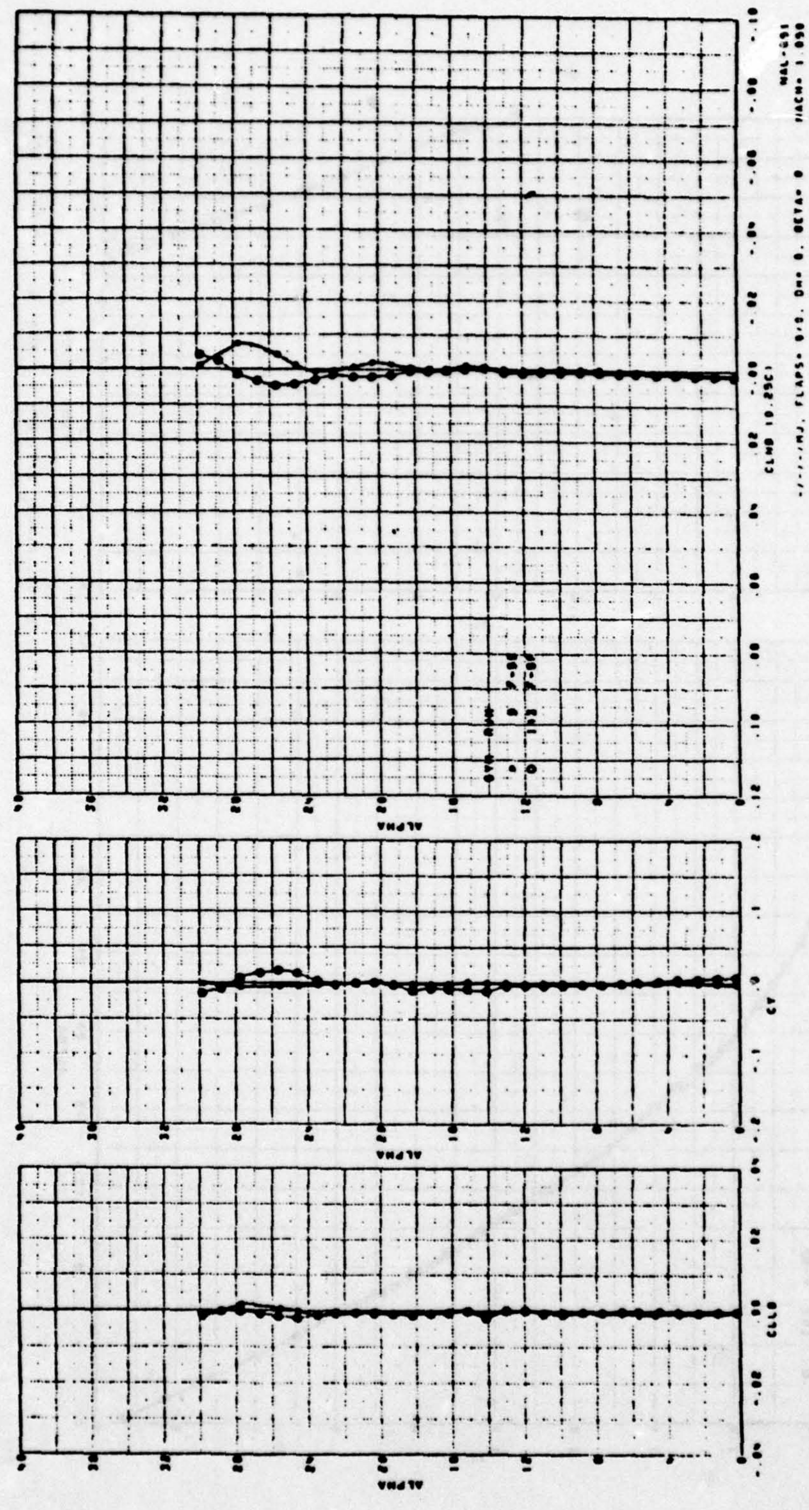


Figure 395. Effects of Increased Nose Length in Pitch at M = 1.05

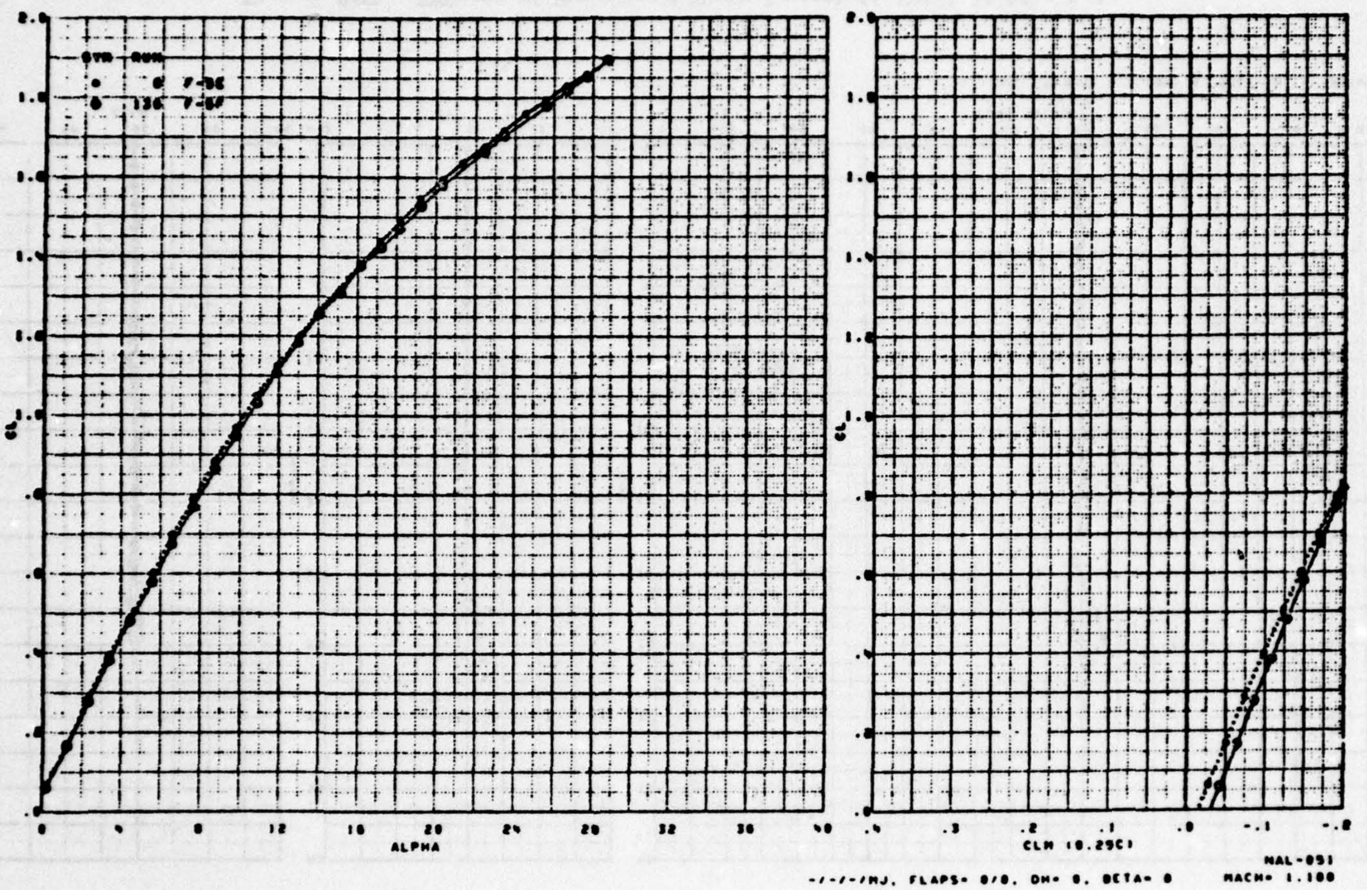


Figure 396. Effects of Increased Nose Length in Pitch at M = 1.1

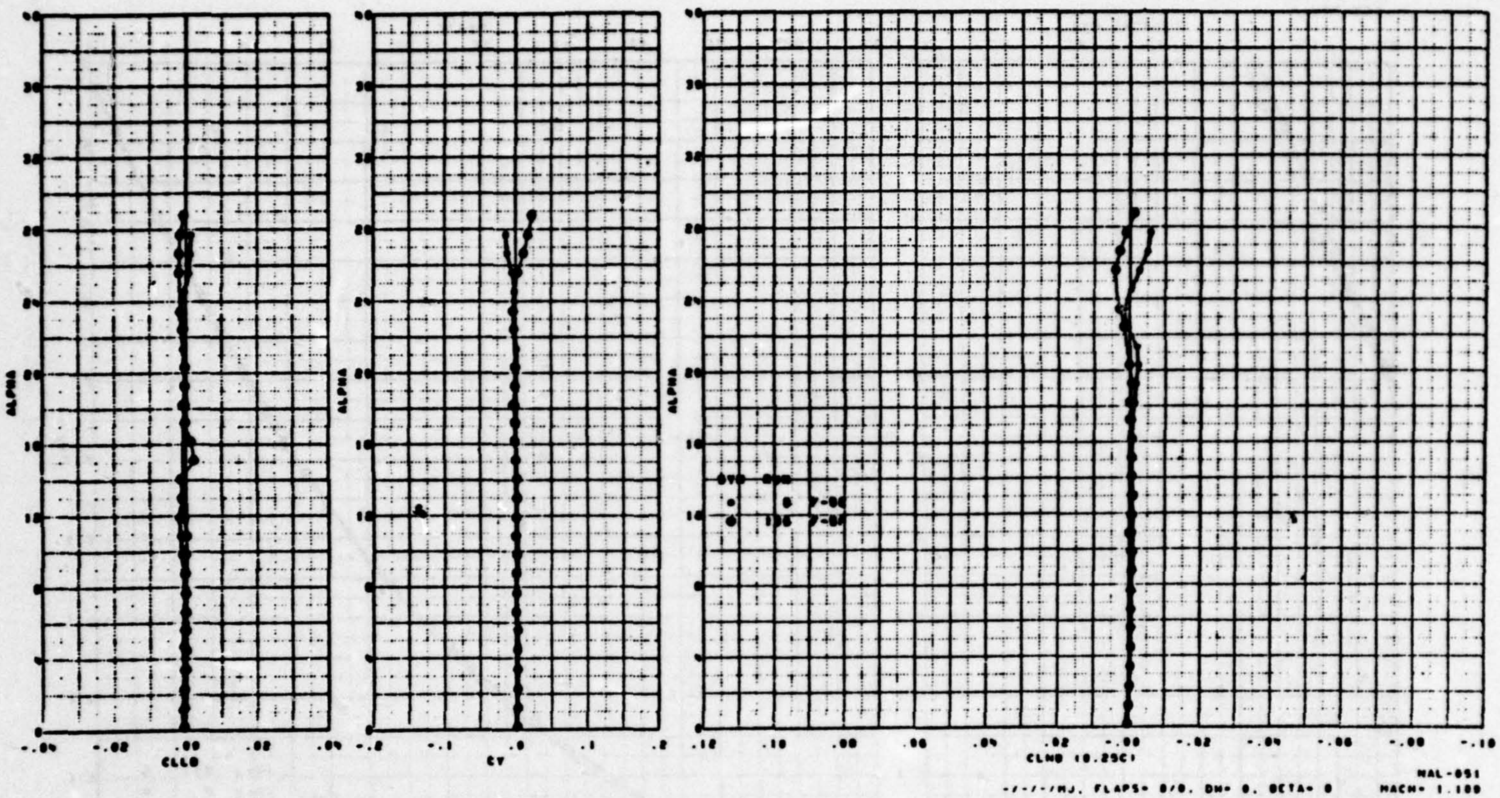


Figure 397. Effects of Increased Nose Length in Pitch at M = 1.1

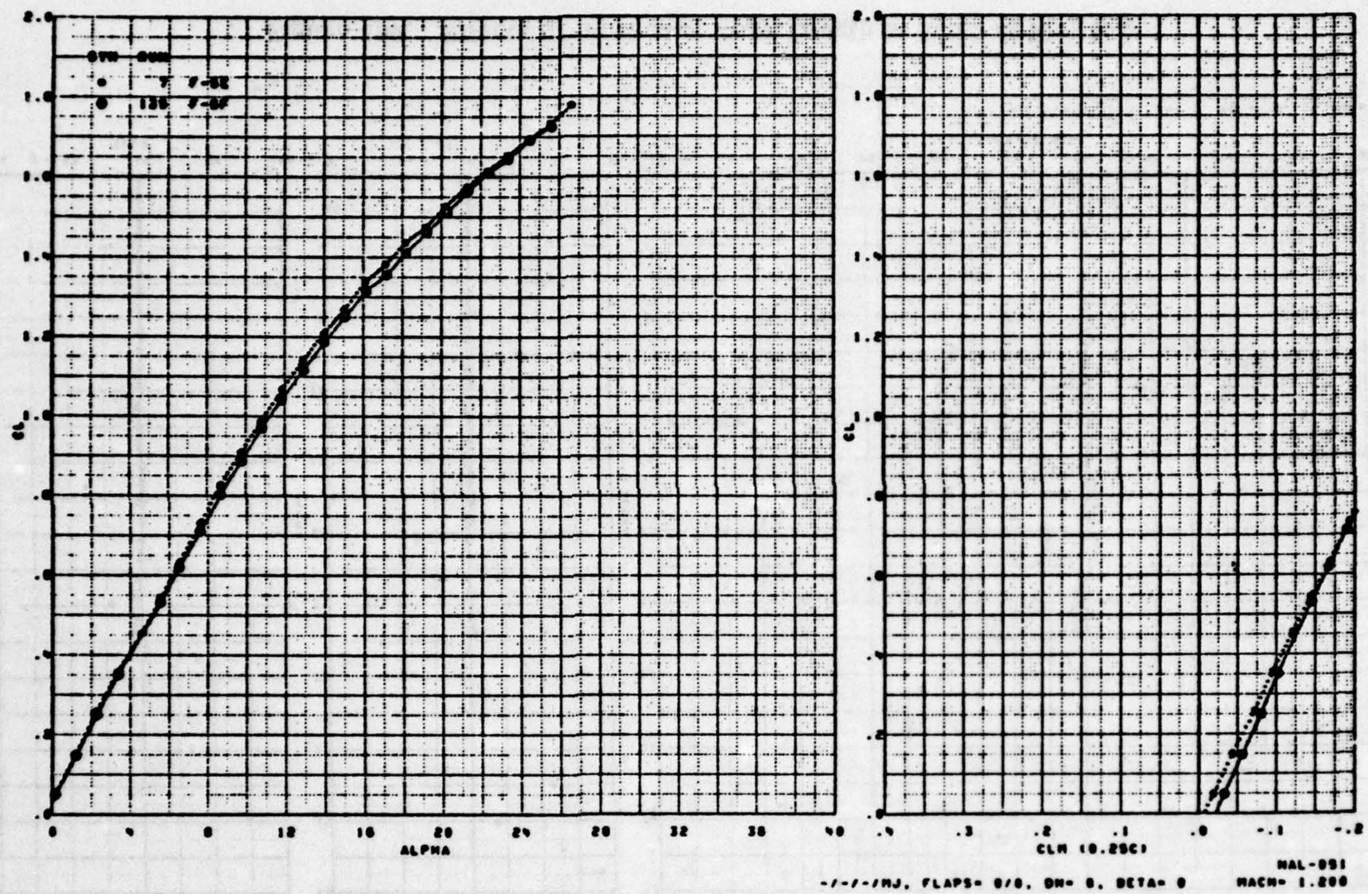


Figure 398. Effects of Increased Nose Length in Pitch at M = 1.2

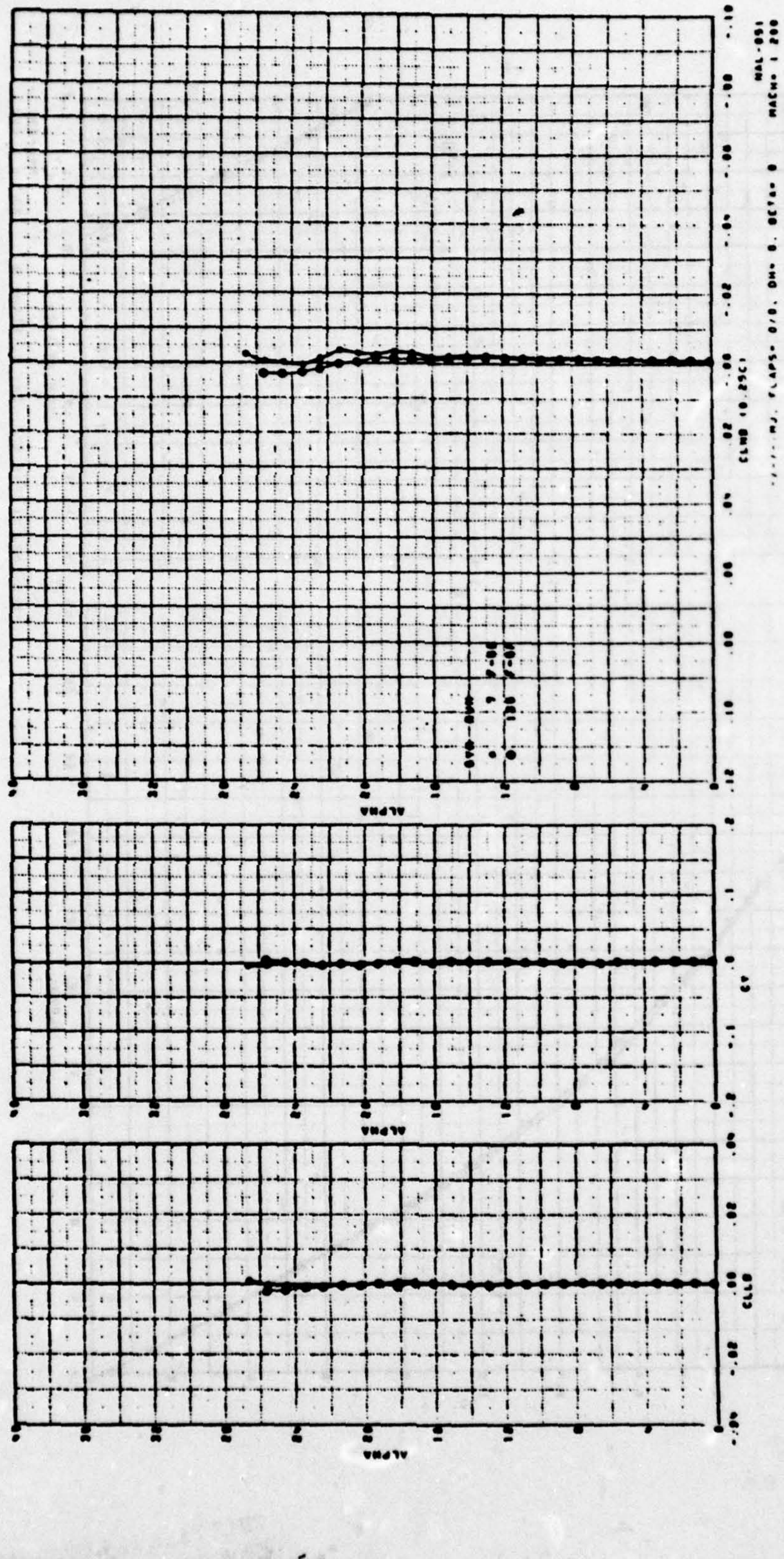


Figure 399. Effects of Increased Nose Length in Pitch at M = 1.2

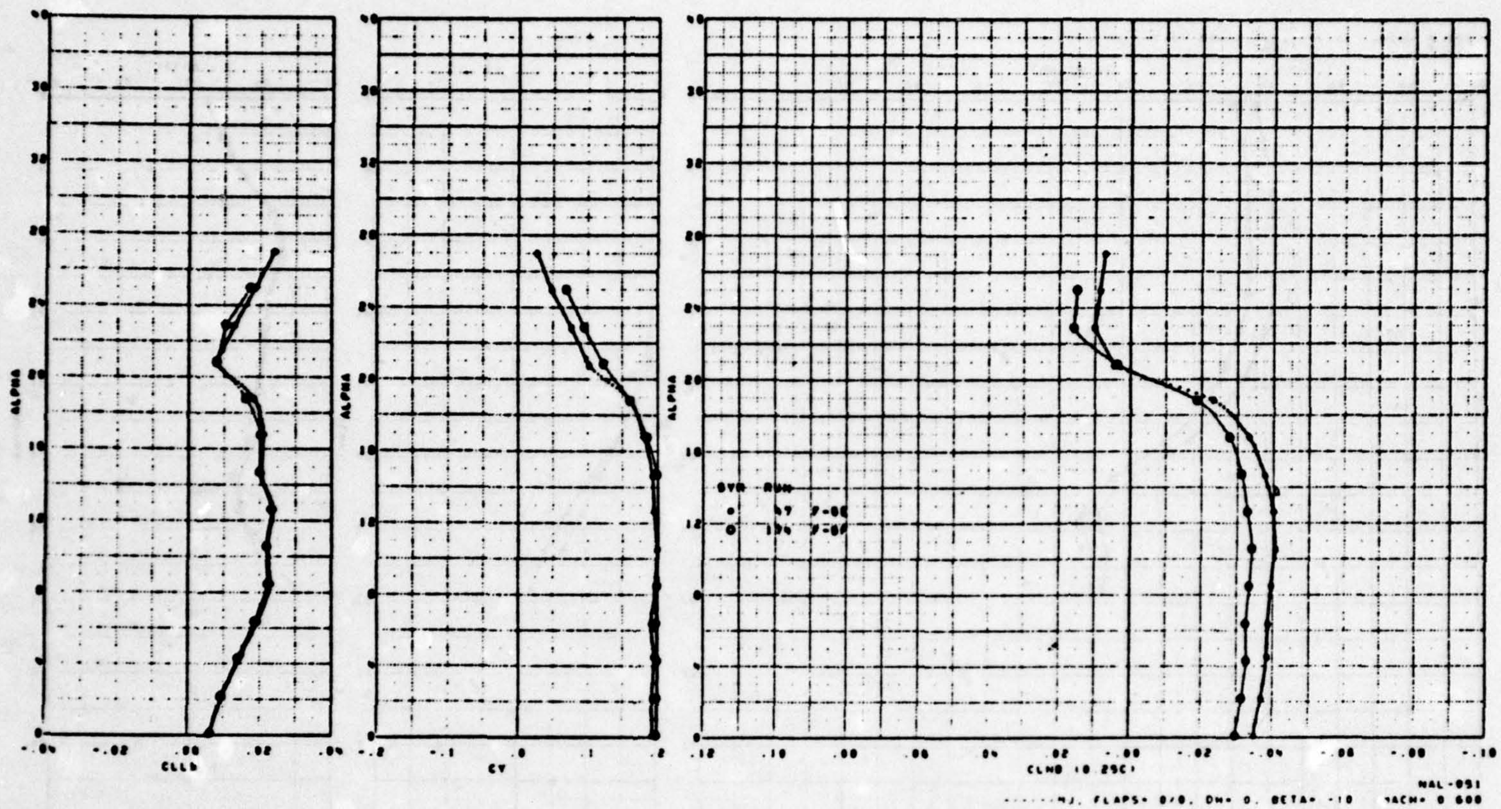


Figure 400. Effects of Increased Nose Length in Sideslip at M = 0.6

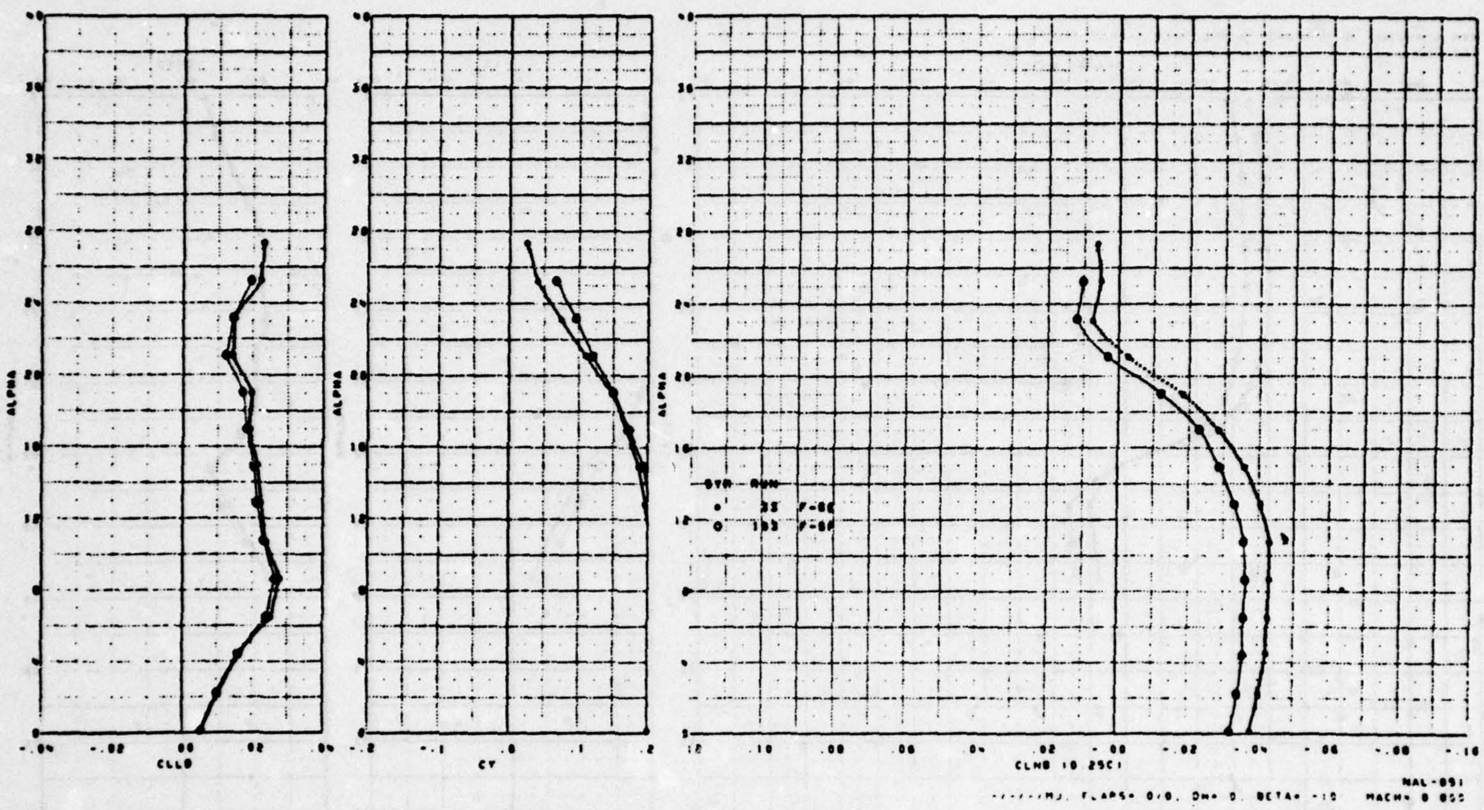


Figure 401. Effects of Increased Nose Length in Sideslip at M = 0.8

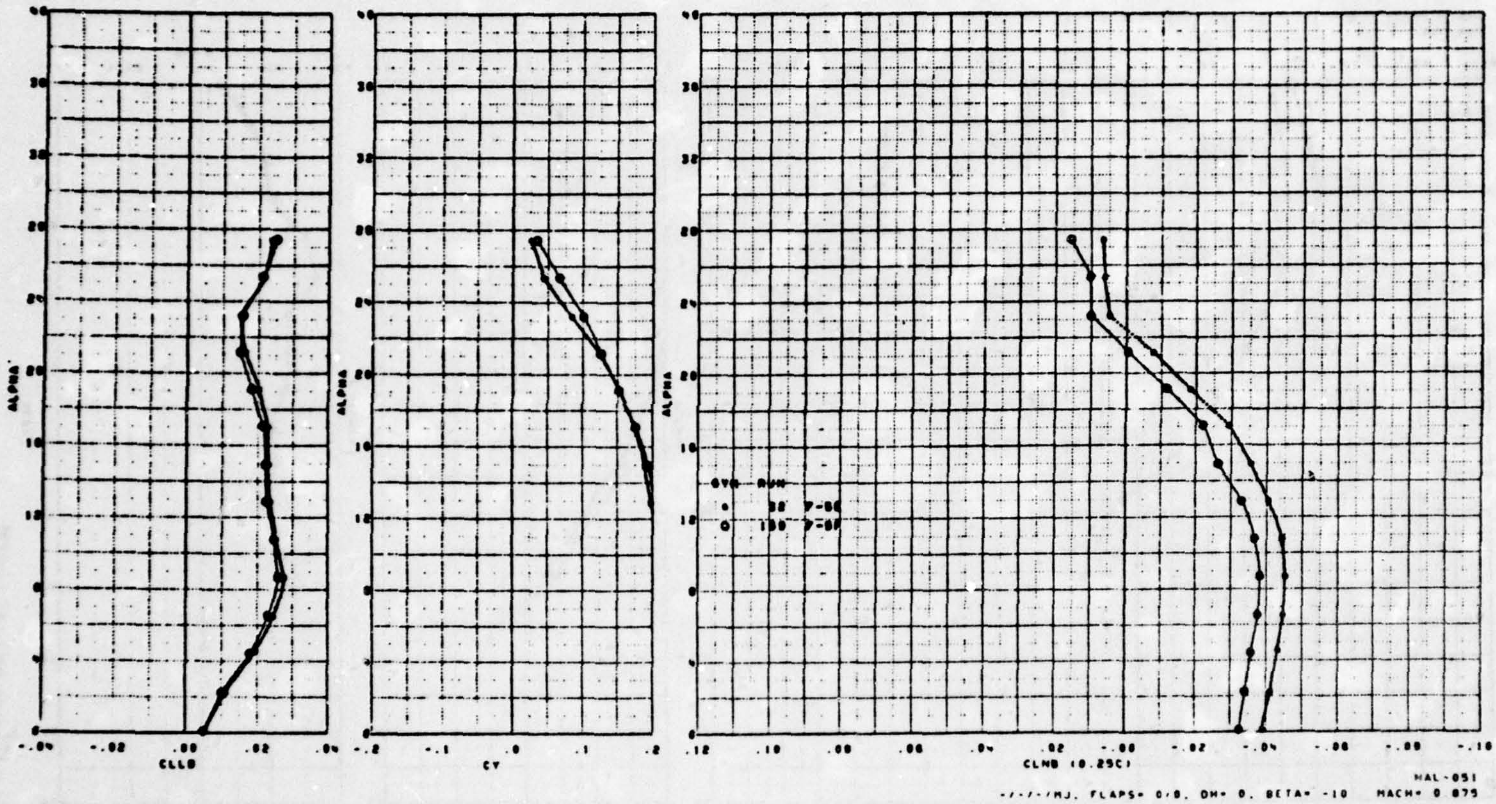


Figure 402. Effects of Increased Nose Length in Sideslip at M = 0.875

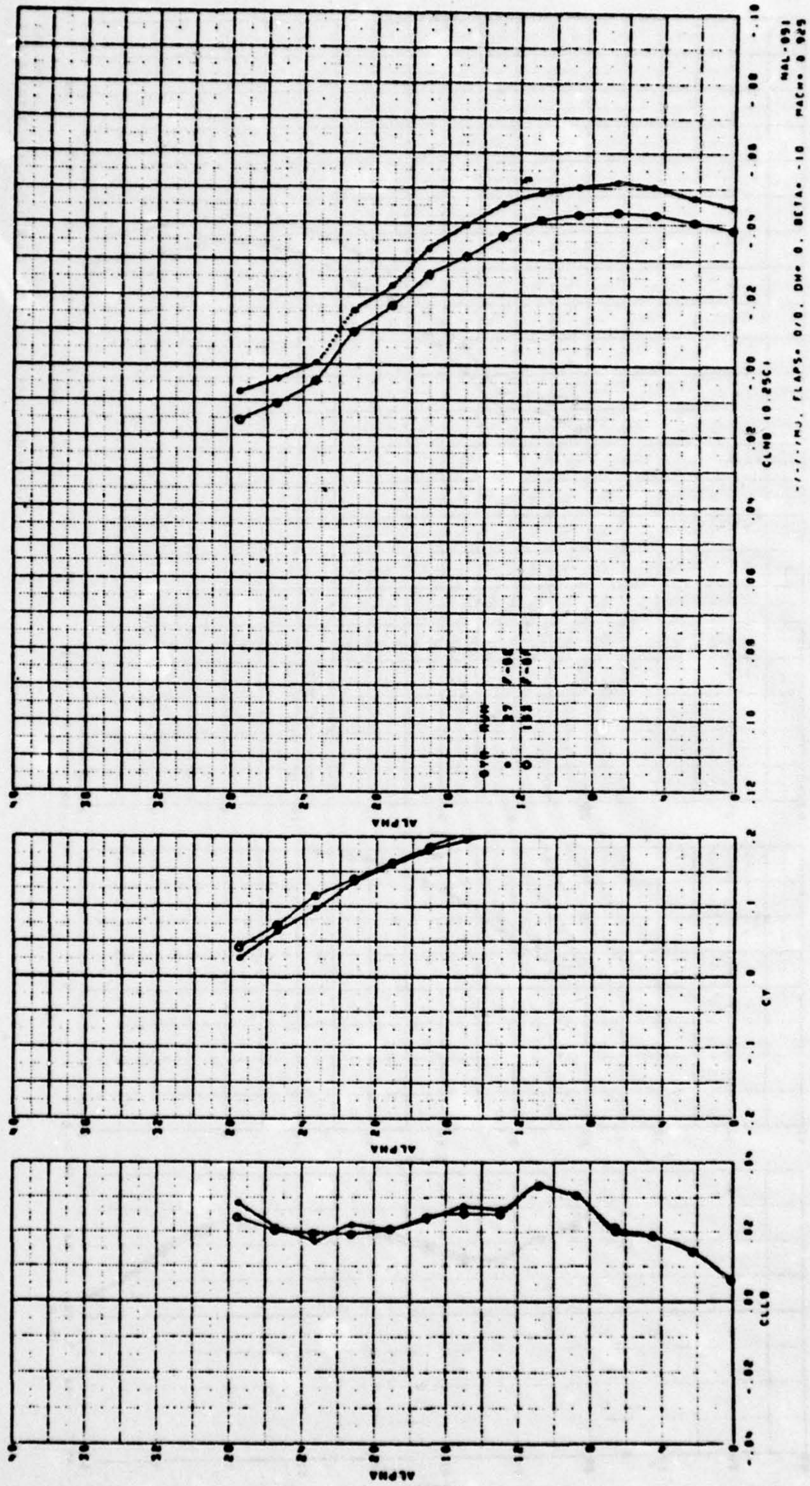


Figure 403. Effects of Increased Nose Length in Sideslip at M = 0.925

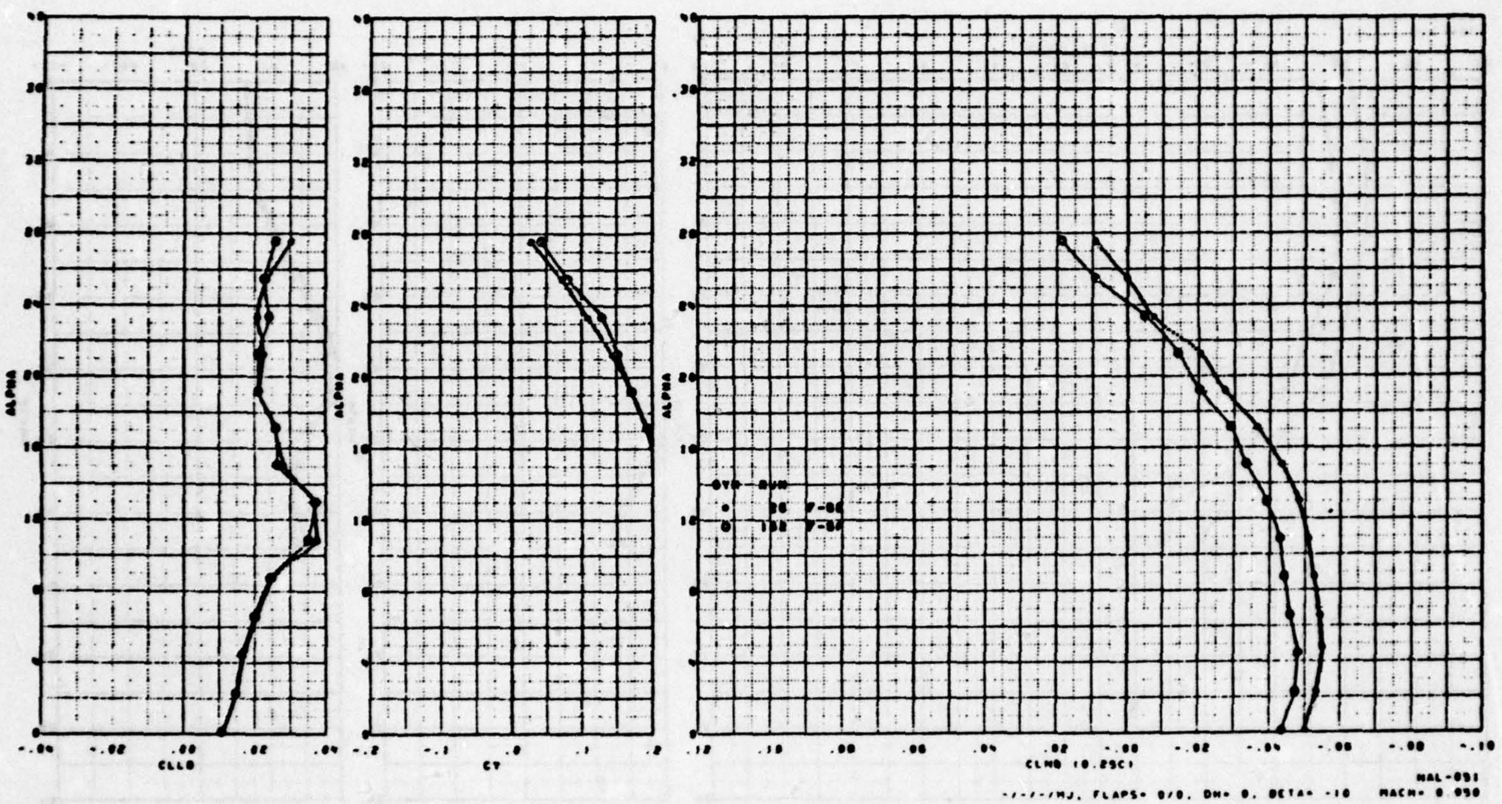


Figure 404. Effects of Increased Nose Length in Sideslip at M = 0.95

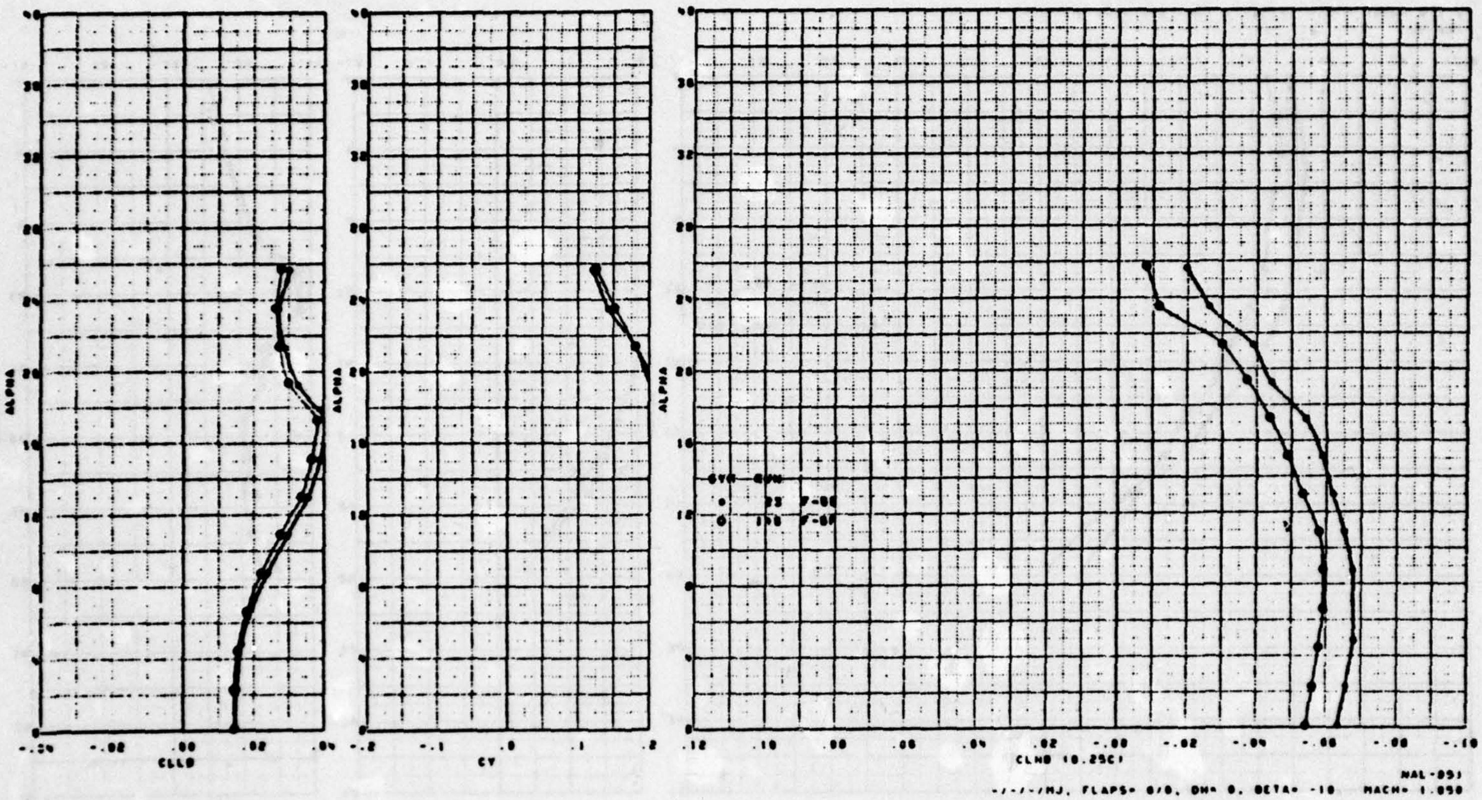


Figure 405. Effects of Increased Nose Length in Sideslip at M = 1.05

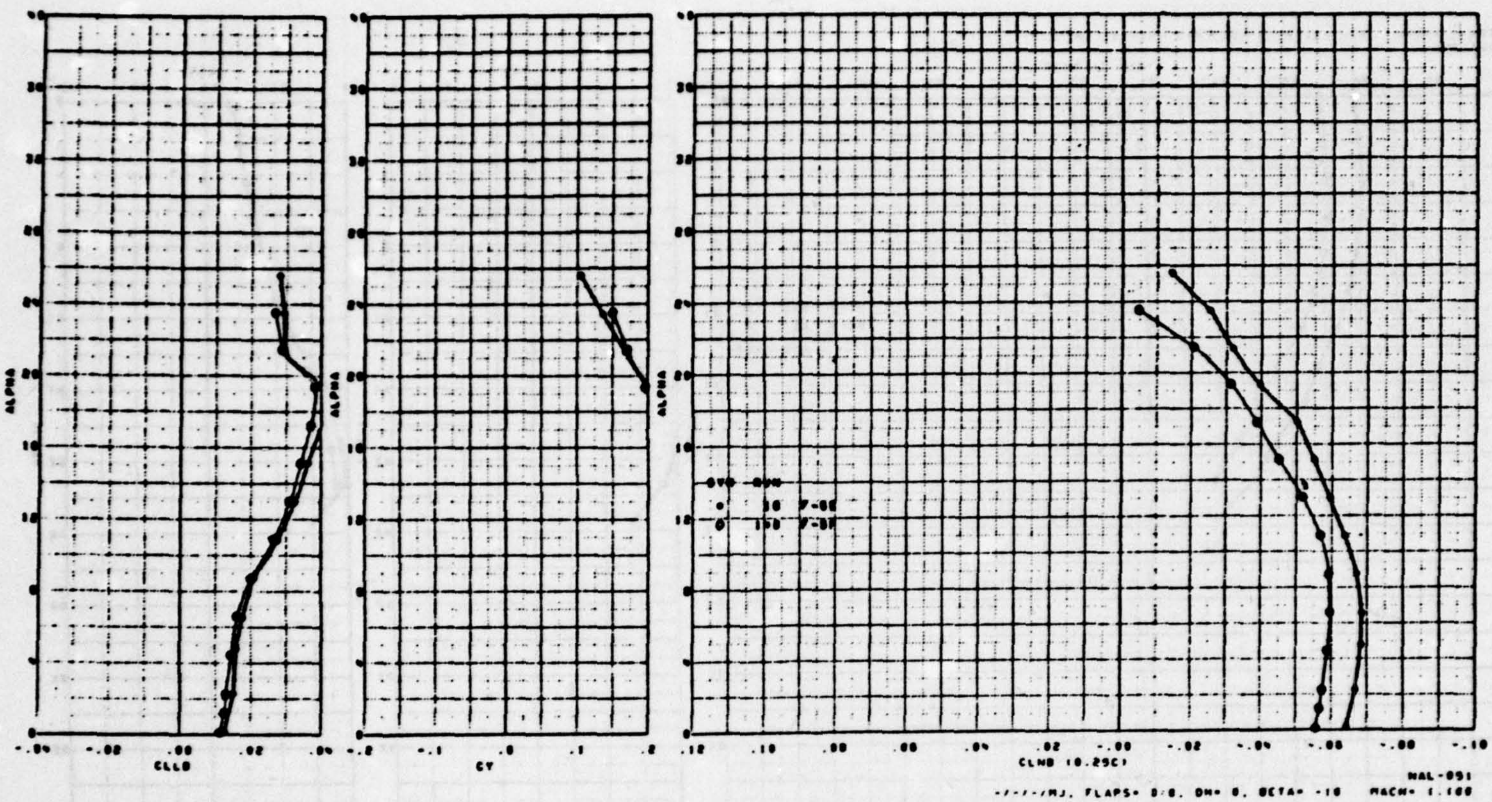


Figure 406. Effects of Increased Nose Length in Sideslip at M = 1.1

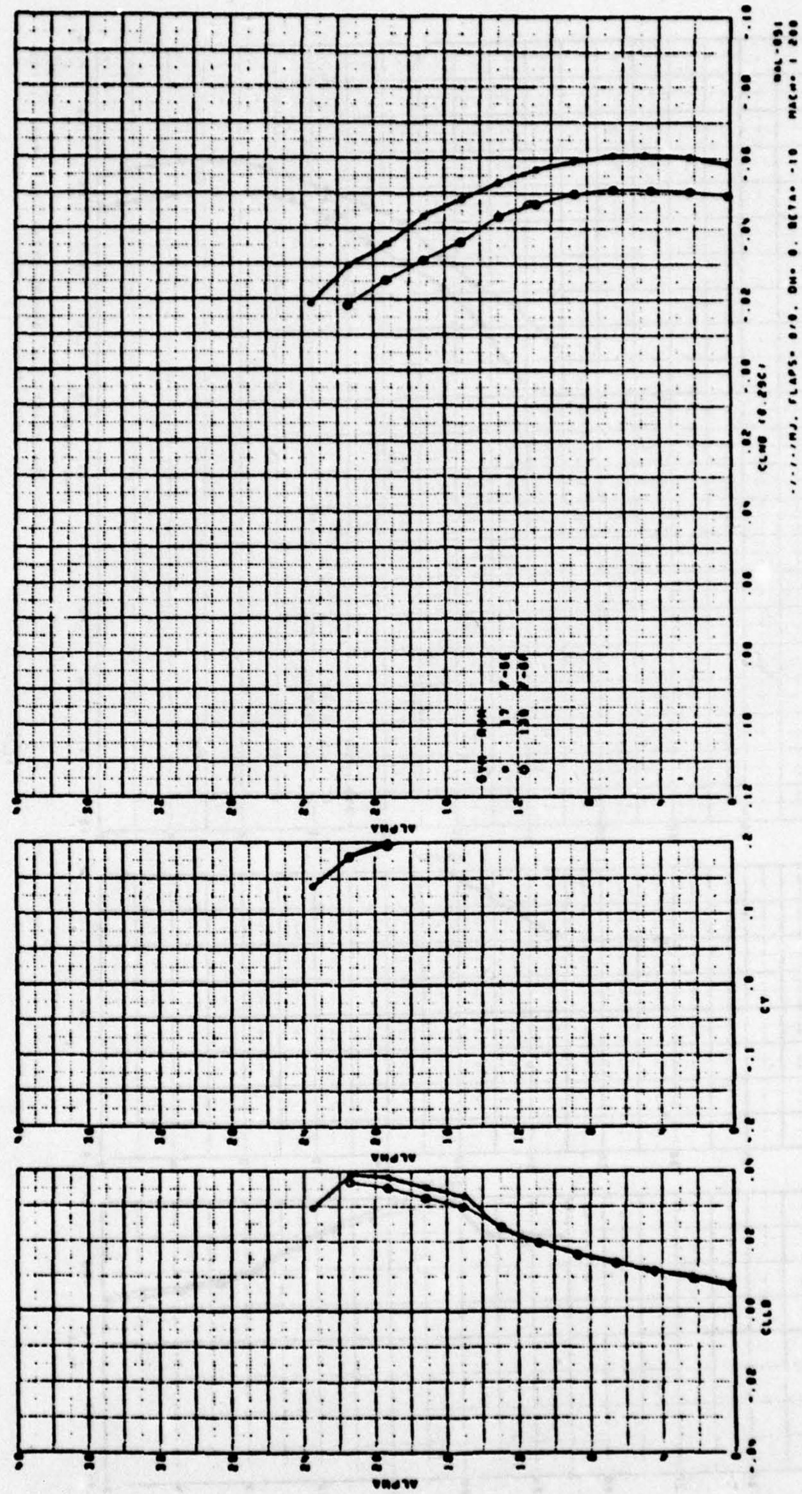


Figure 407. Effects of Increased Nose Length in Sideslip at M = 1.2

AIRCRAFT | F-5E/F | REFERENCE | 59

TEST REPORT

NOR 76-18 — Data Report of a Transonic Wind Tunnel Test of a 10% Scale F-5E/F Force Model in the AEDC 16 T Transonic Wind Tunnel (August 1975 Test)

R. A. Dawson — NAL-132

REPORT SUMMARY

This report presents force and moment coefficient data from a transonic wind tunnel test of a 10% model of the F-5E/F aircraft conducted at the Arnold Engineering Development Center (AEDC) 16 Foot Transonic Wind Tunnel. The test program was conducted during the period 4 to 20 August, 1975.

The objectives of the test were to obtain basic aerodynamic characteristics of the aircraft with and without external stores, horizontal tail panel loads, and external store loads. Both configurations (F-5E and F-5F) were also tested with a reconnaissance nose, and with RHAW antenna and IRCM devices.

TEST CONDITIONS

Mach No.	=	0.6 - 1.5
R.N./Foot	=	2.0×10^6
A.O.A. Range	=	Various
Sideslip Range	=	Various

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 208.

CONFIGURATION CHANGES

Sketches of F-5E/F nose configuration changes applicable to this study are shown in Figure 312.

DATA EFFECTS PERTINENT TO THE HIGH ANGLE OF ATTACK STUDY

Figures 408 through 417 show a comparison of the lateral/directional characteristics at zero sideslip of the base and blunt noses for the F-5E, B1, B10, for Mach Numbers 0.6, 0.8, 0.875, 0.925, 0.95, 1.05, 1.10, 1.20, 1.40 and 1.50.

A similar range of Mach Number data comparisons for the F-5F noses, B2, B11, are shown in Figures 418 through 427.

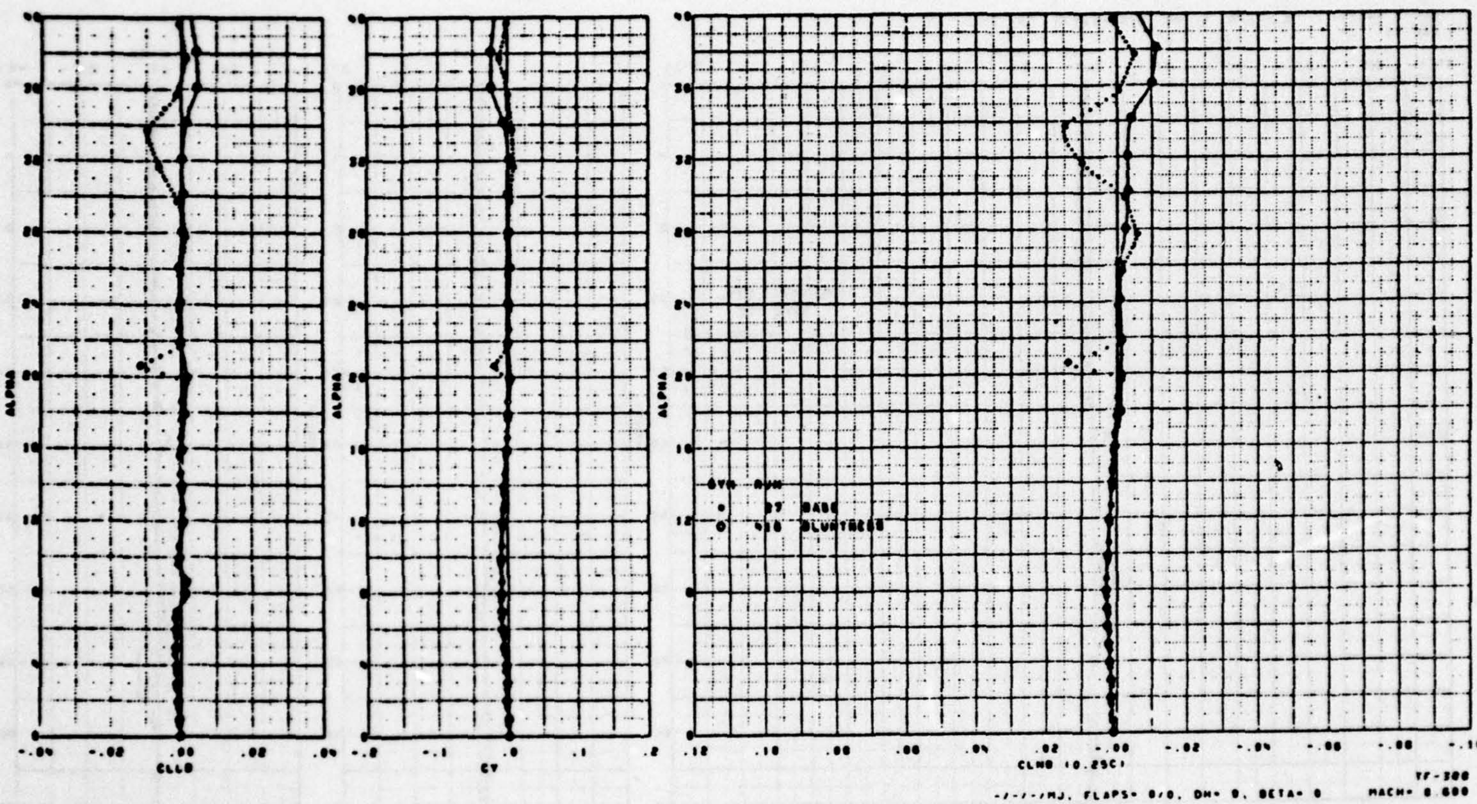


Figure 408. F-5E Effect of Nose Bluntness at Zero Sideslip, M = 0.6

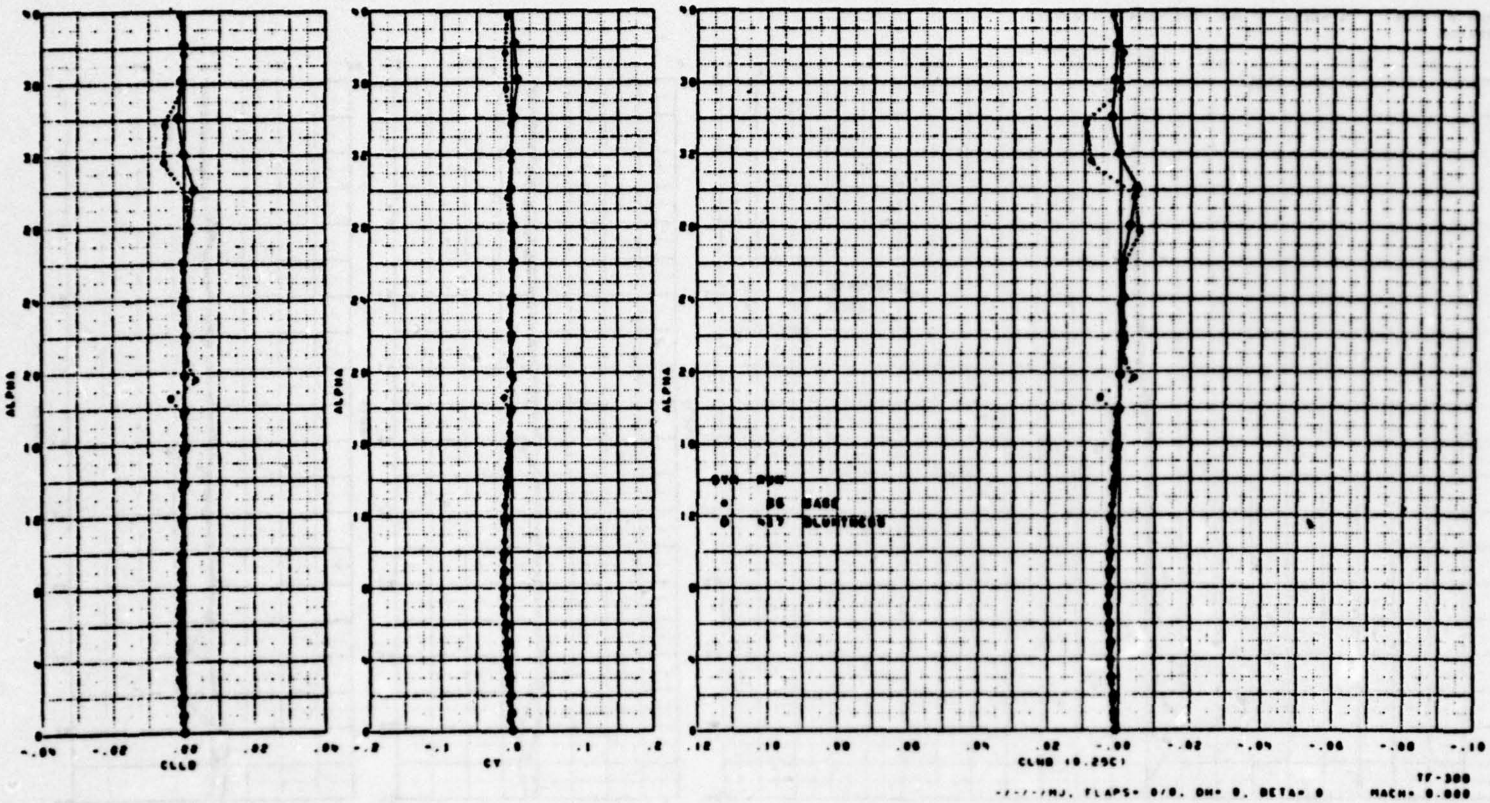


Figure 409. F-5E Effect of Nose Bluntness at Zero Sideslip, M = 0.8

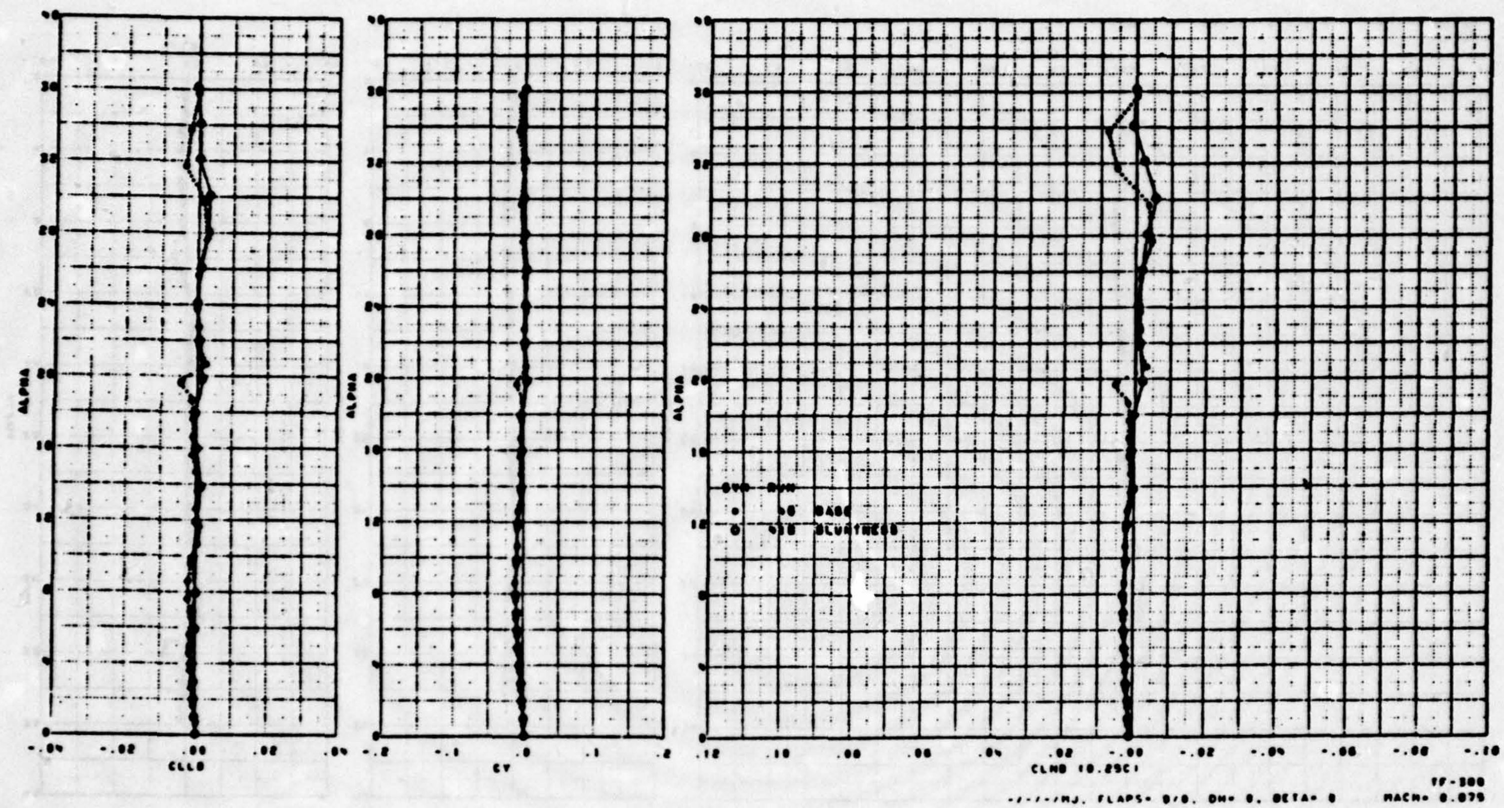


Figure 410. F-5E Effect of Nose Bluntness at Zero Sideslip, M = 0.875

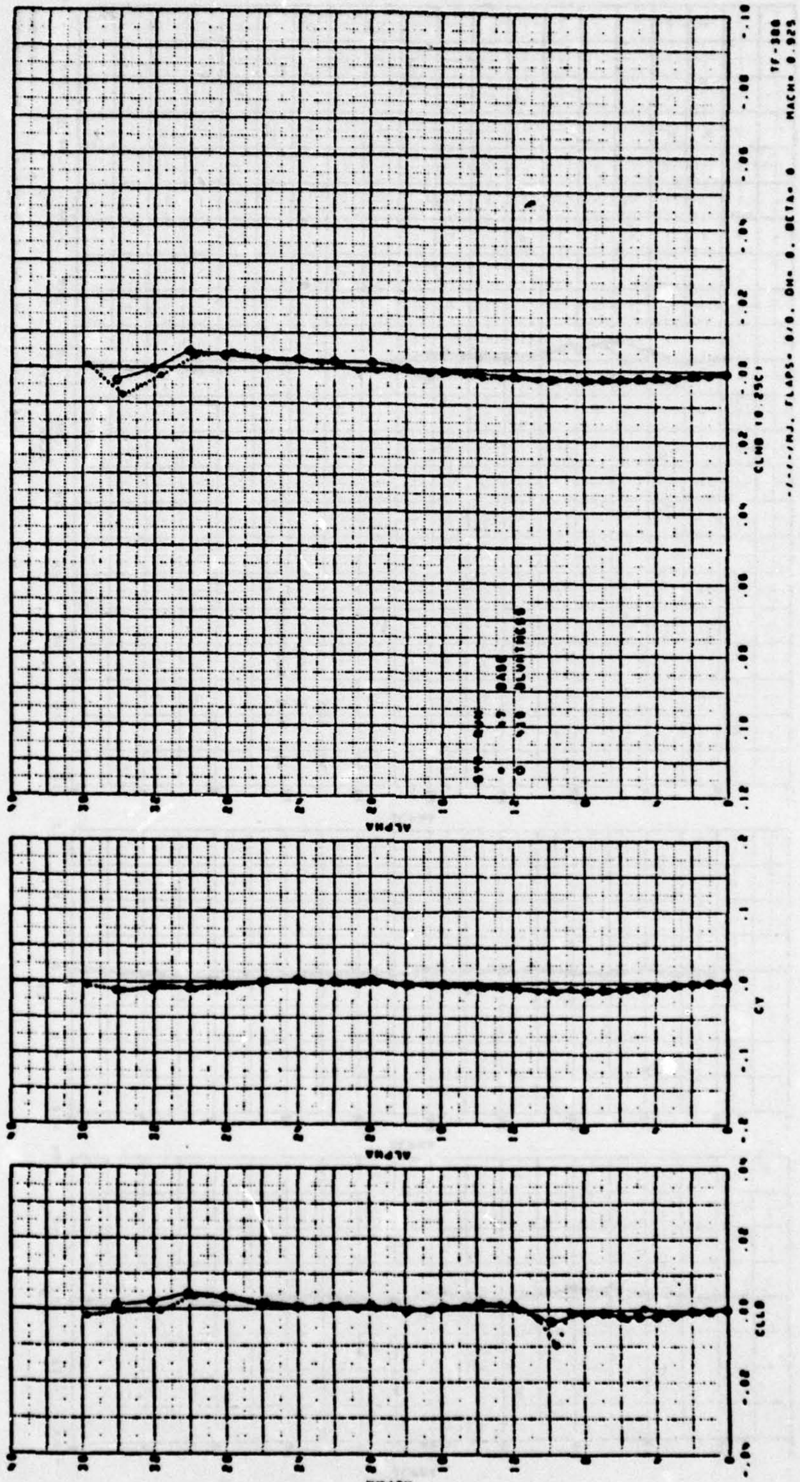


Figure 411. F-5E Effect of Nose Bluntness at Zero Sideslip, M = 0.925

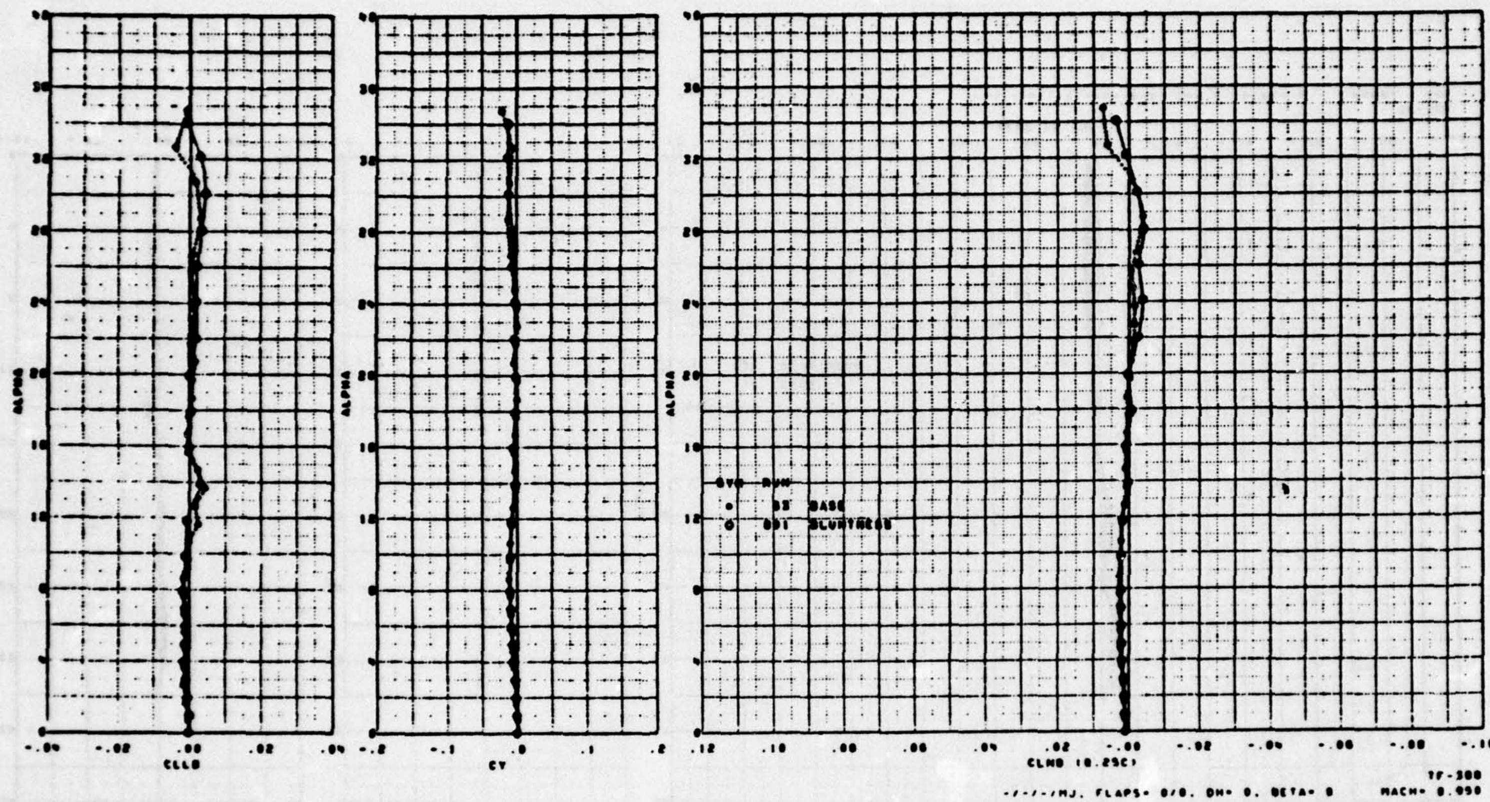


Figure 412. F-5E Effect of Nose Bluntness at Zero Sideslip, M = 0.95

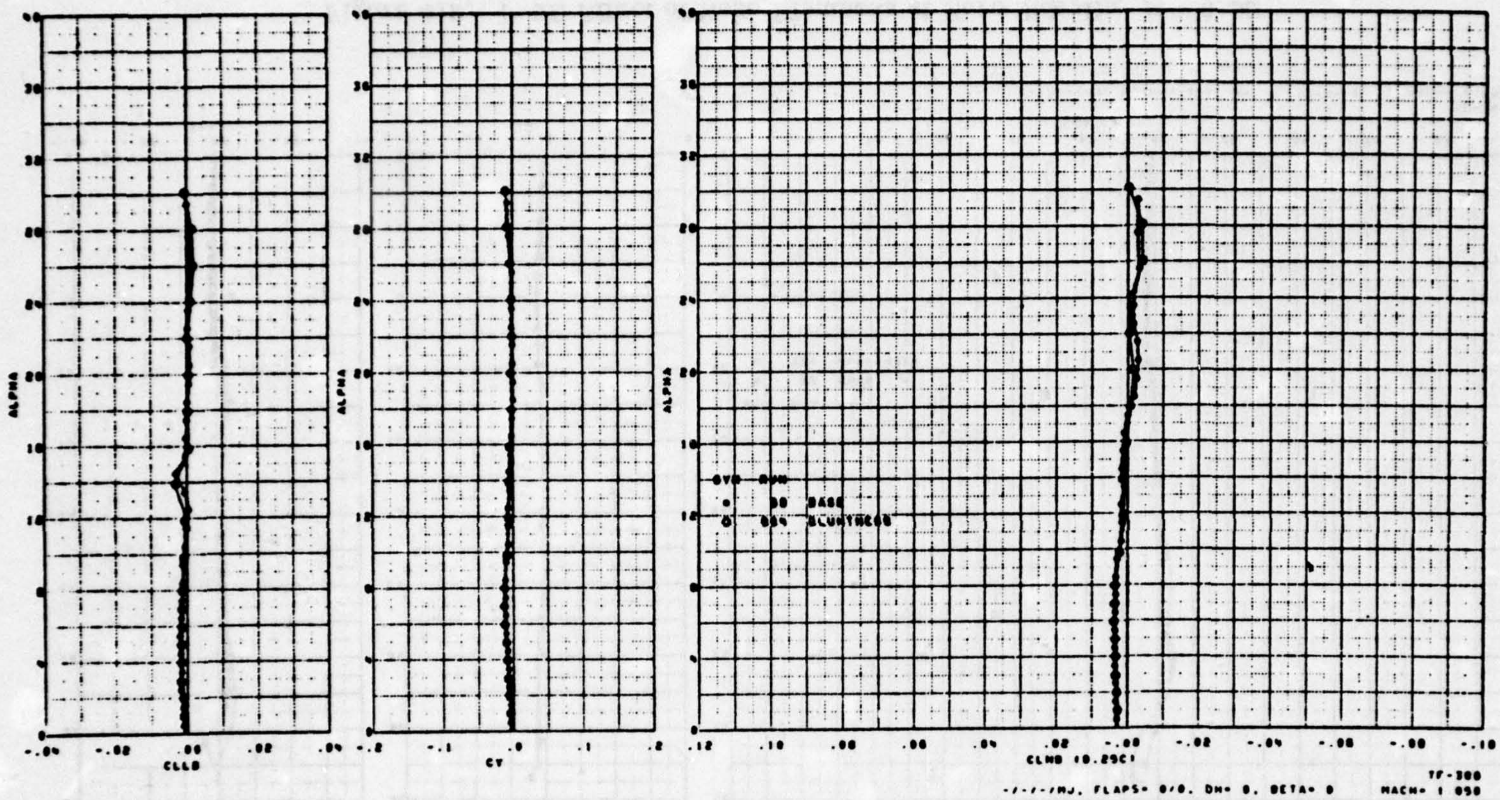


Figure 413. F-5E Effect of Nose Bluntness at Zero Sideslip, M = 1.05

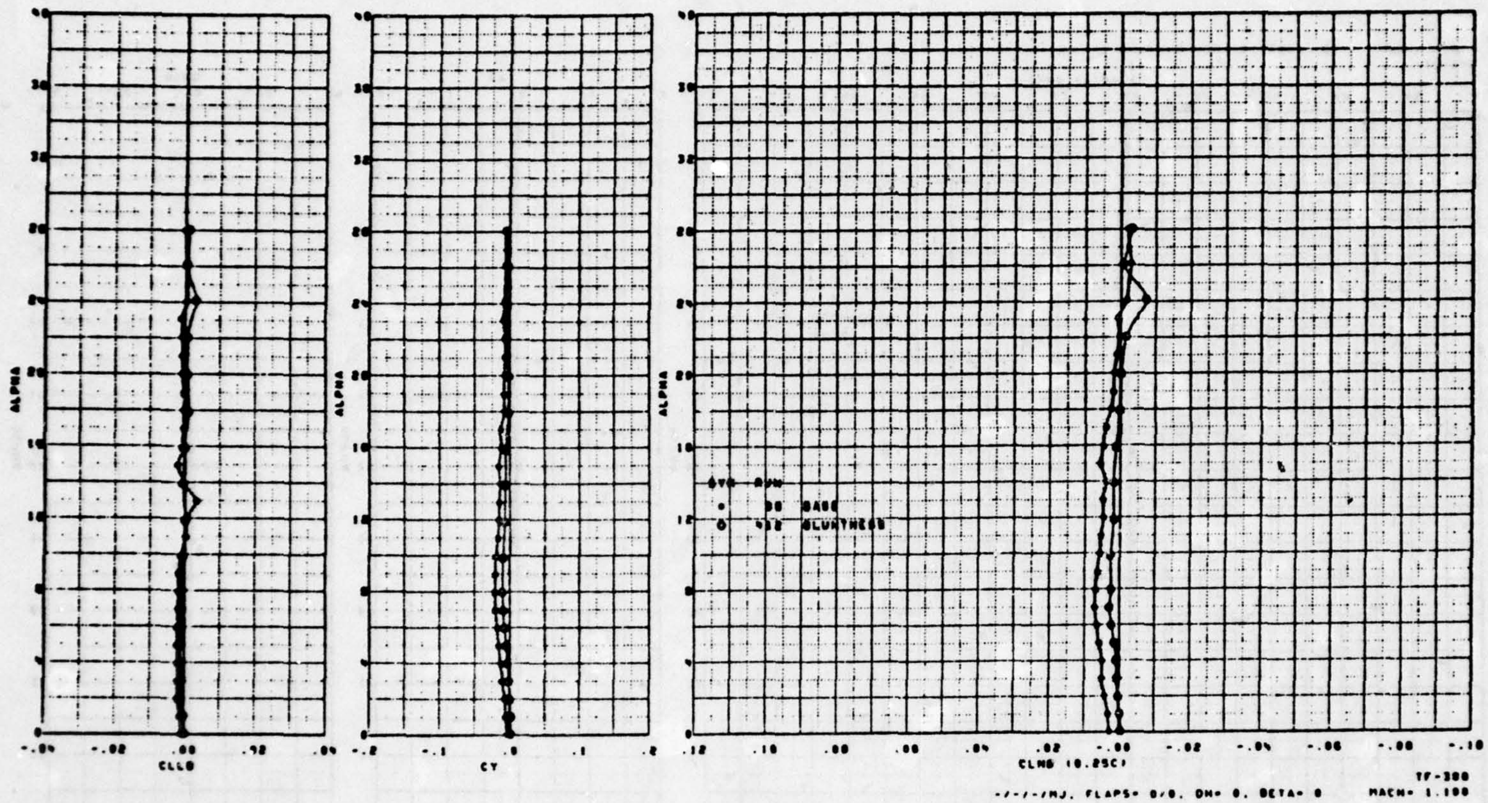


Figure 414. F-5E Effect of Nose Bluntness at Zero Sideslip, M = 1.1

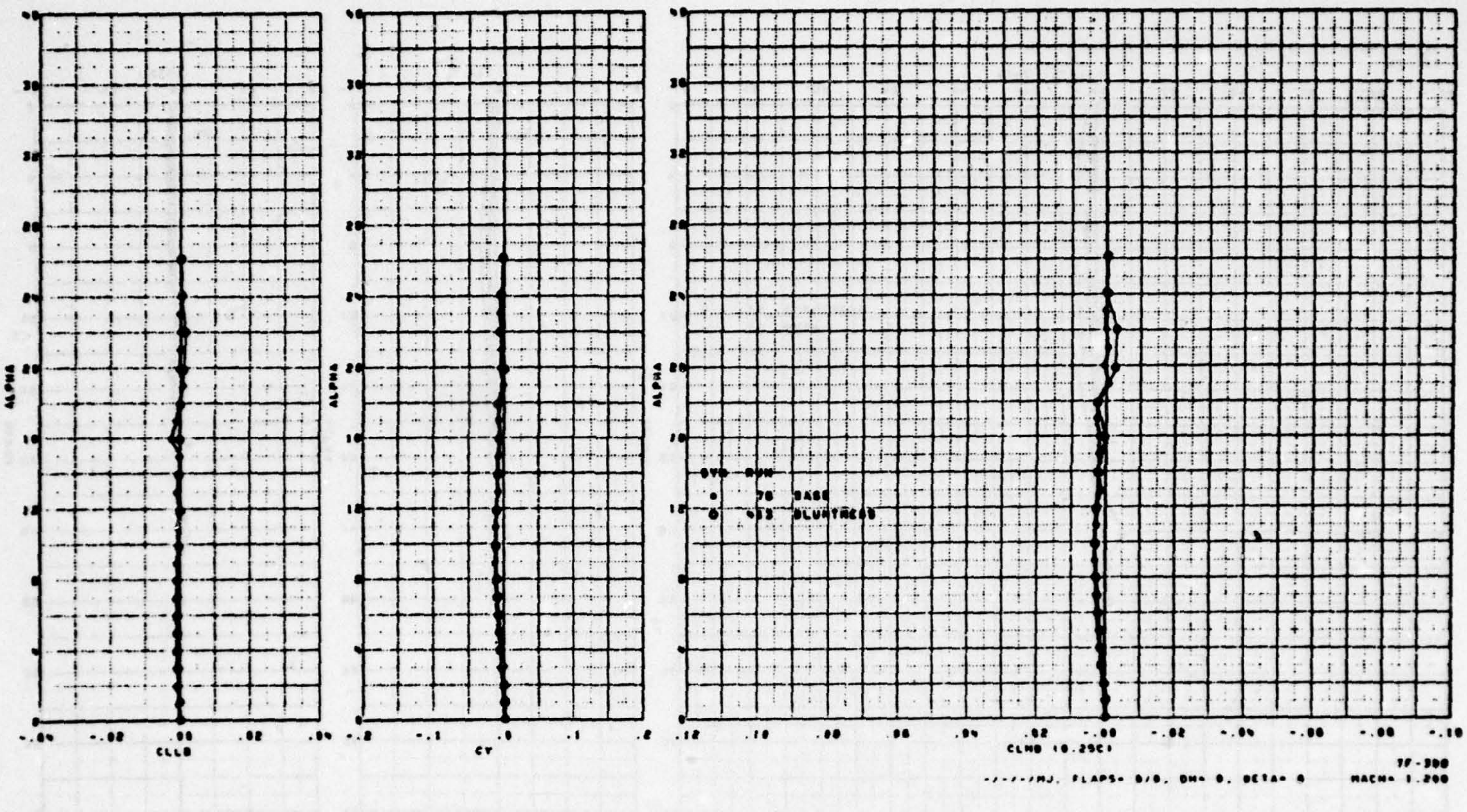


Figure 415. F-5E Effect of Nose Bluntness at Zero Sideslip, M = 1.2

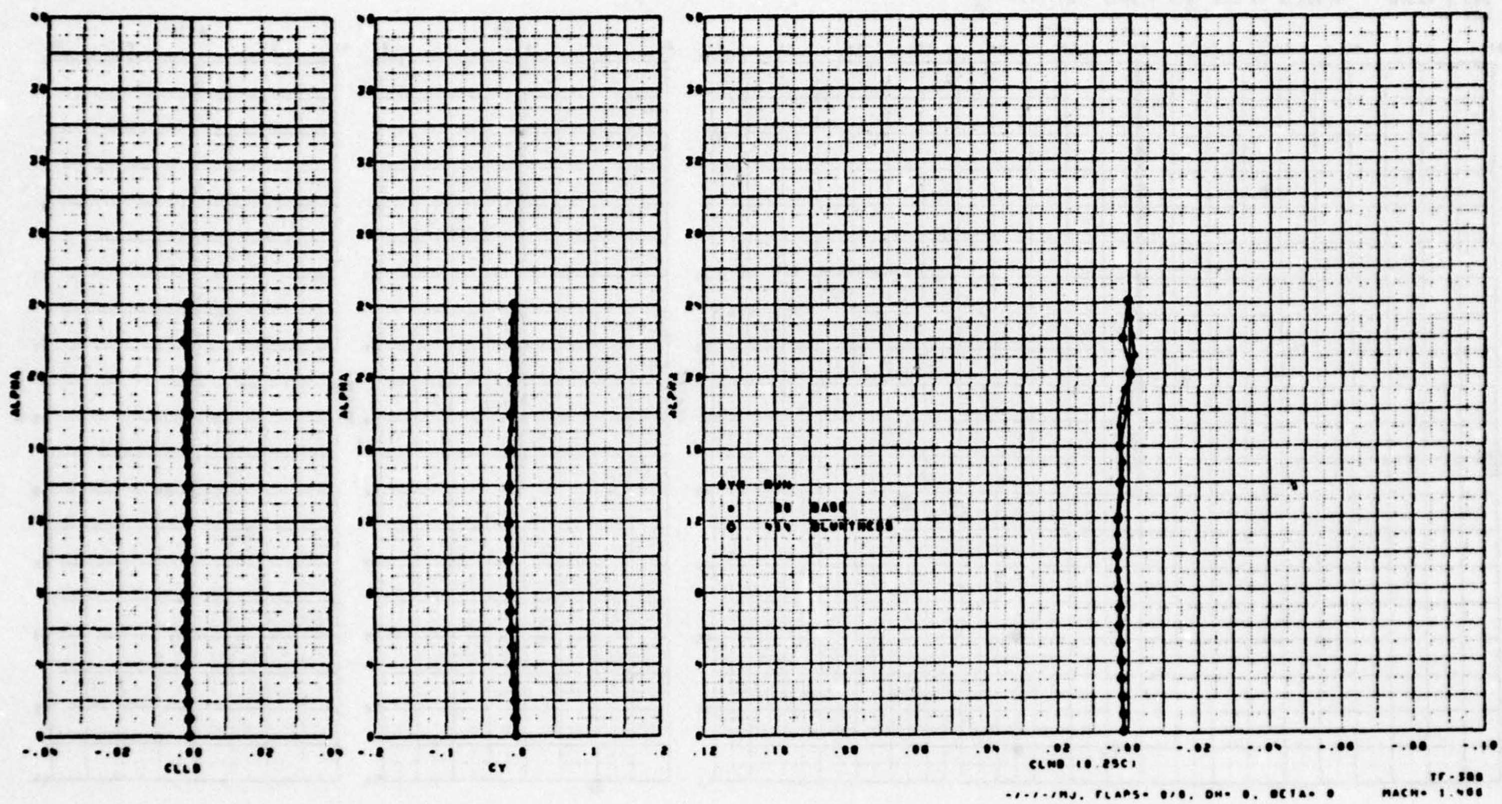


Figure 416. F-5E Effect of Nose Bluntness at Zero Sideslip, M = 1.4

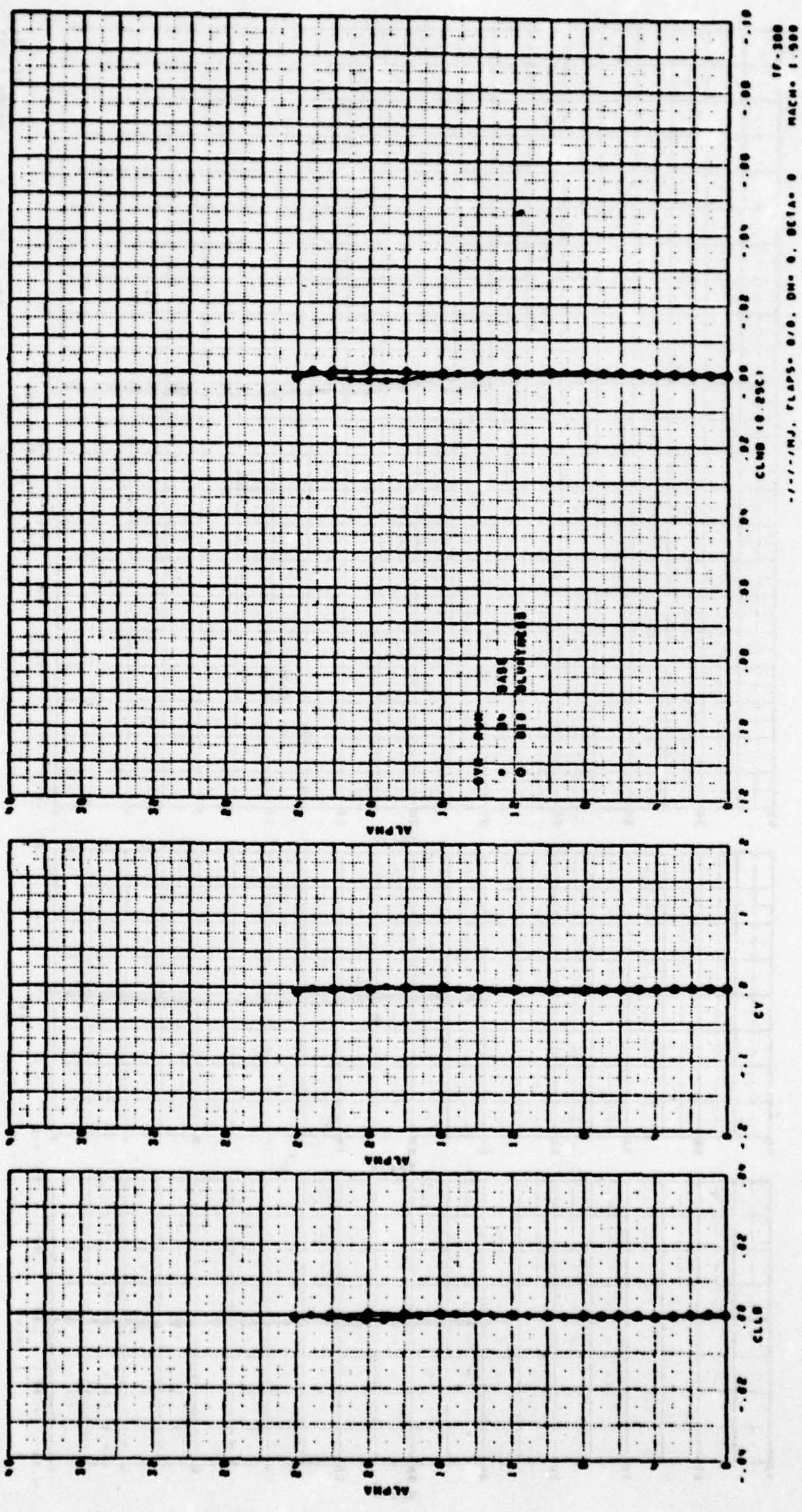


Figure 417. F-5E Effect of Nose Bluntness at Zero Sideslip, M = 1.5

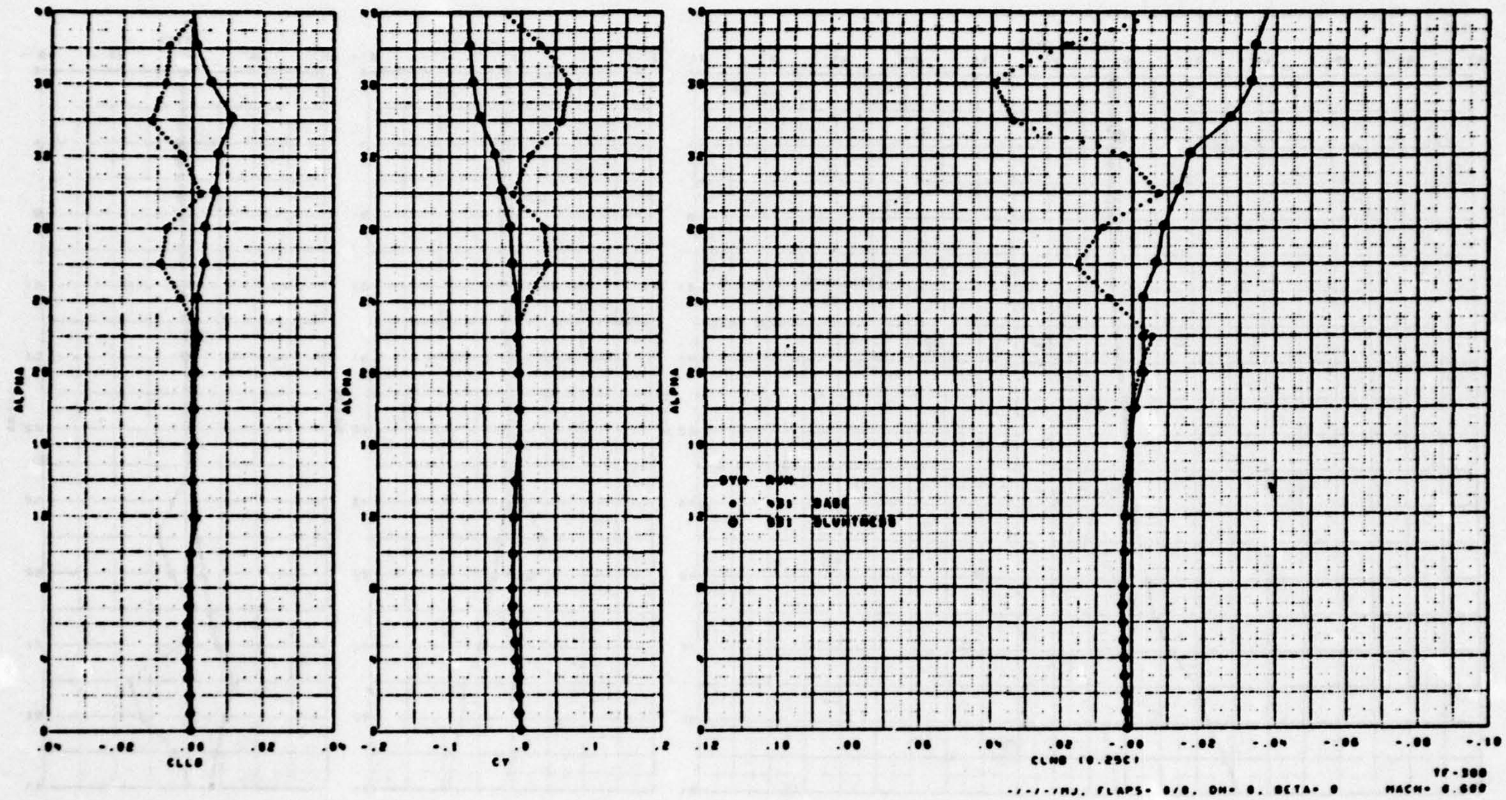


Figure 418. F-5F Effect of Nose Bluntness at Zero Sideslip, M = 0.6

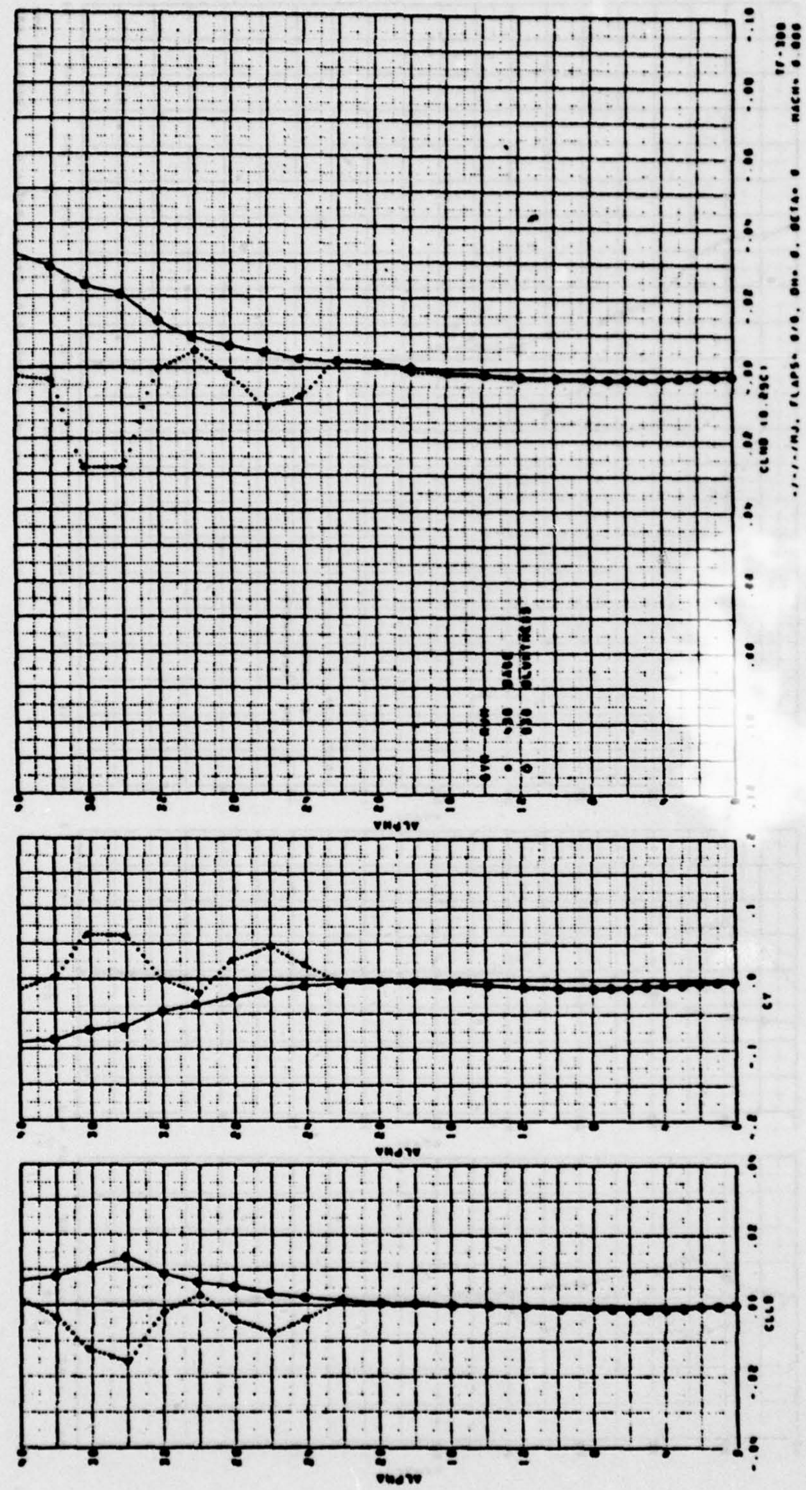


Figure 419. F-5F Effect of Nose Bluntness at Zero Sideslip, M = 0.8

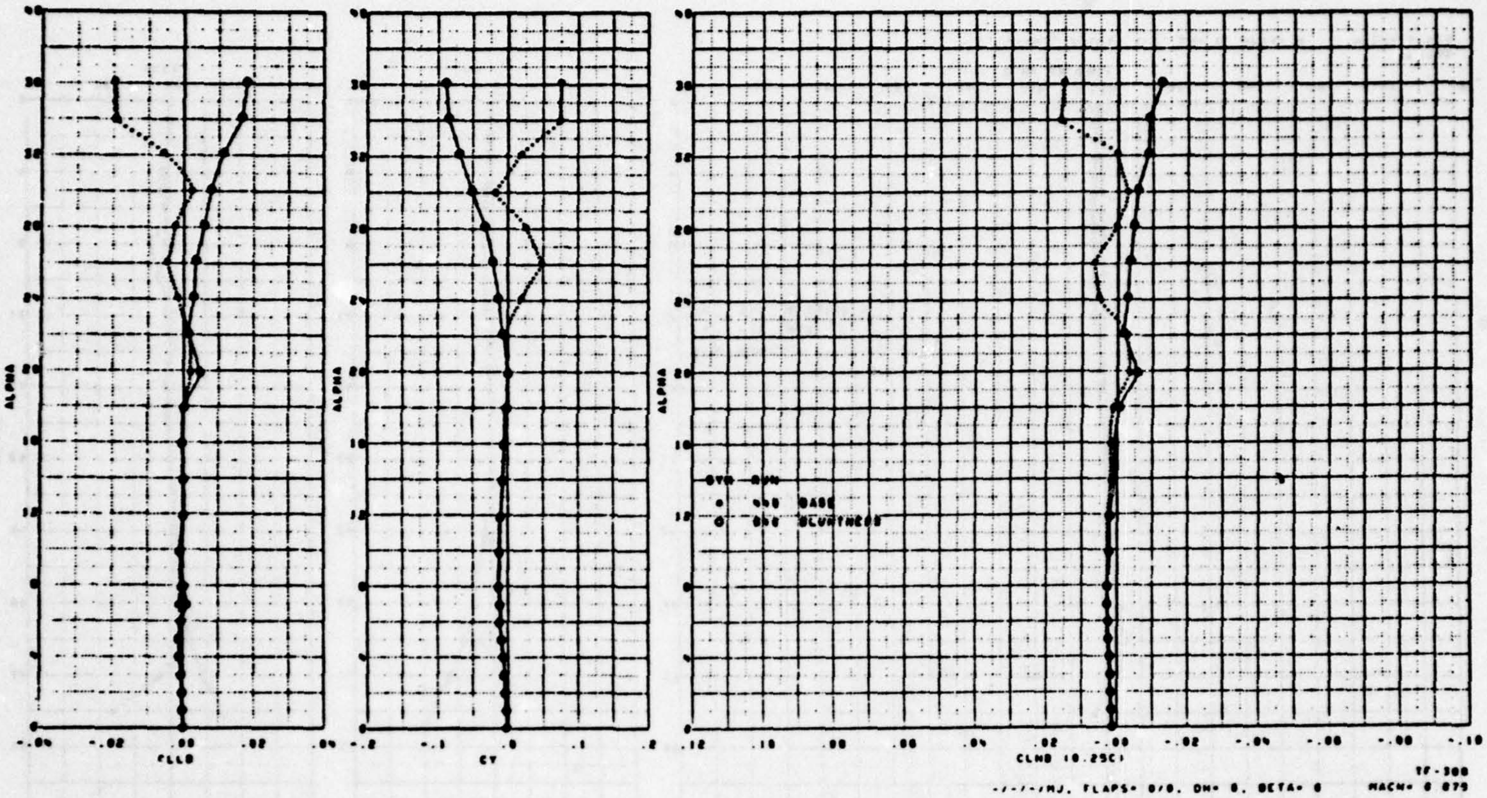


Figure 420. F-5F Effect of Nose Bluntness at Zero Sideslip, M = 0.875

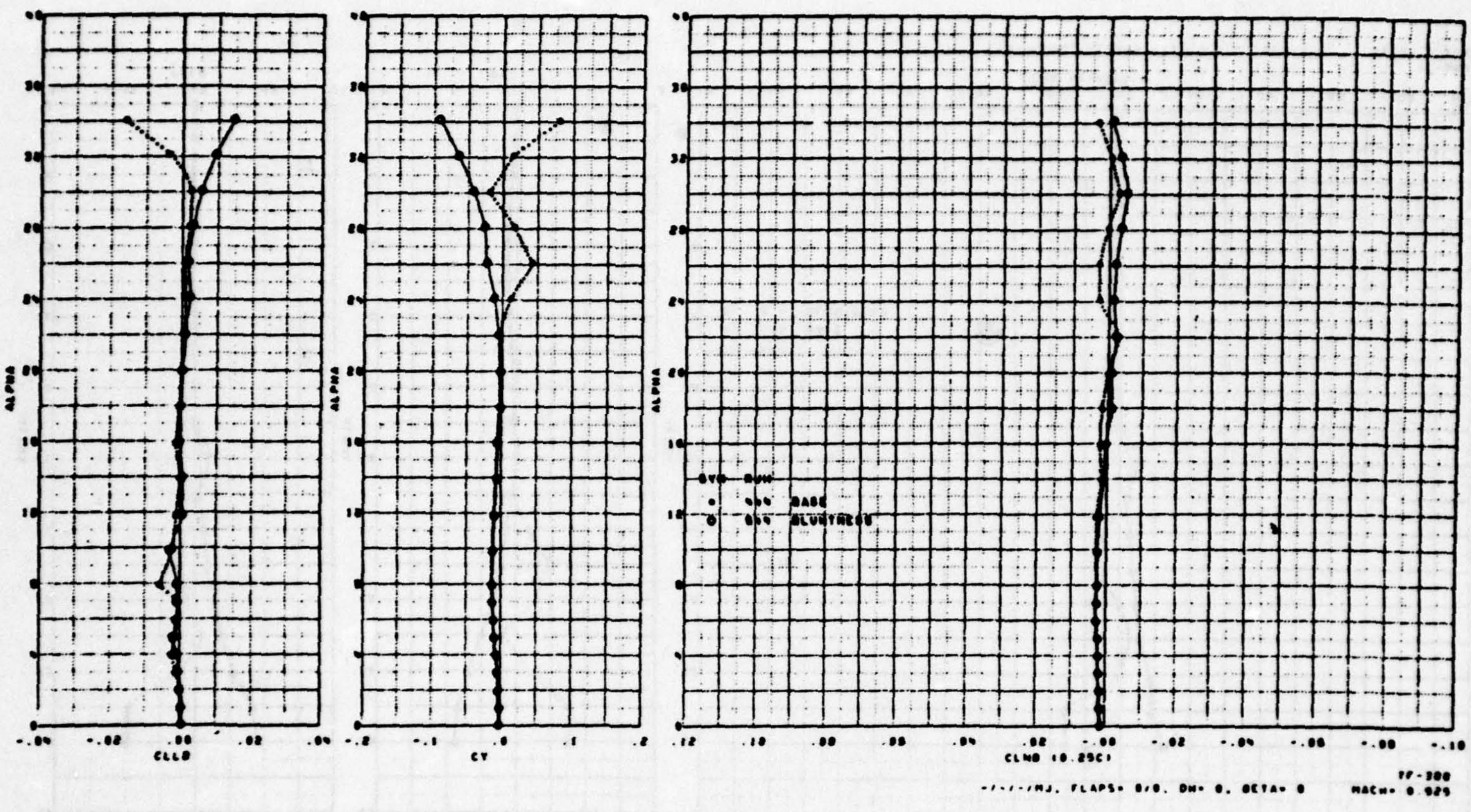


Figure 421. F-5F Effect of Nose Bluntness at Zero Sideslip, M = 0.925

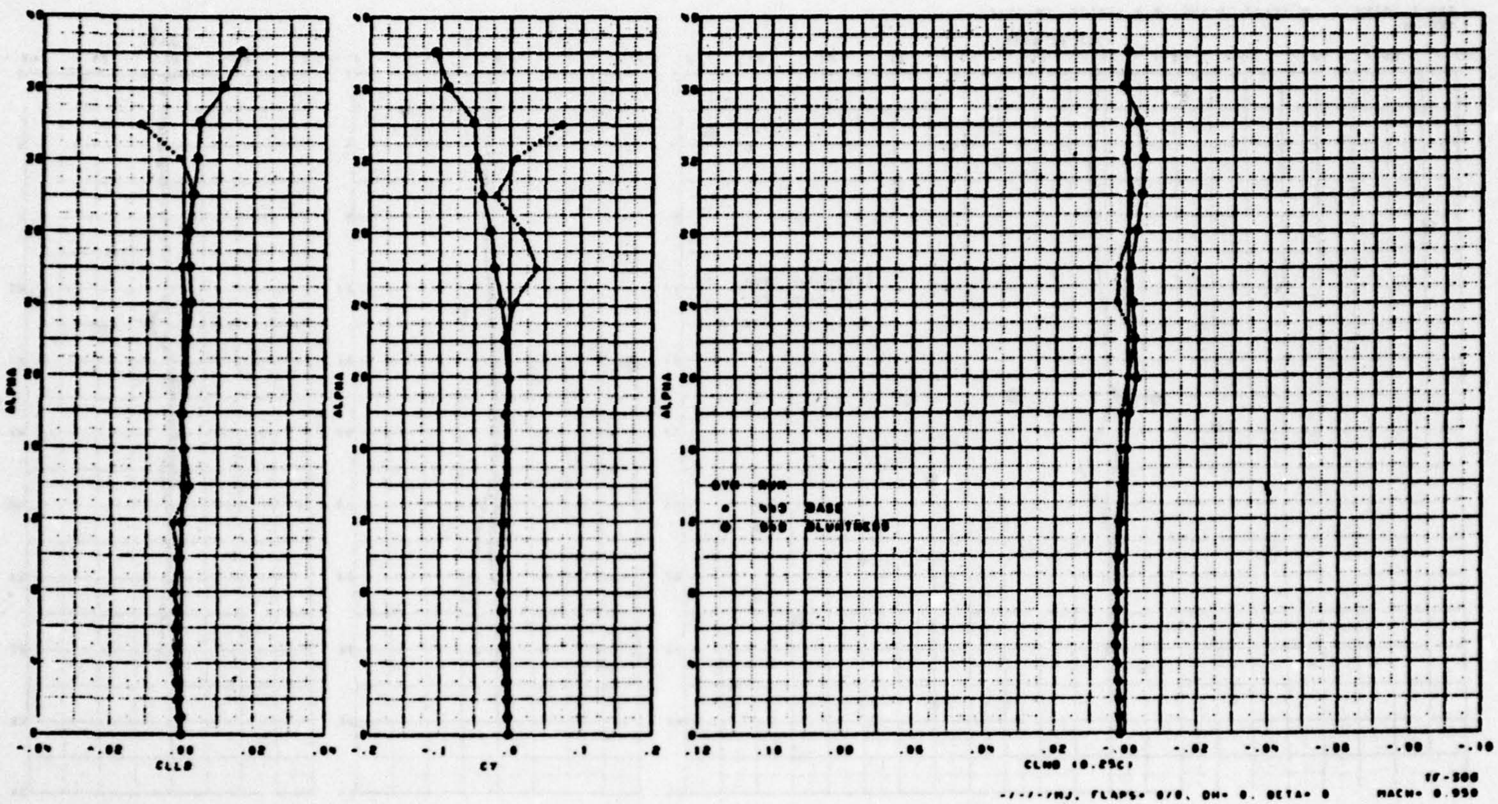


Figure 422. F-5F Effect of Nose Bluntness at Zero Sideslip, M = 0.95

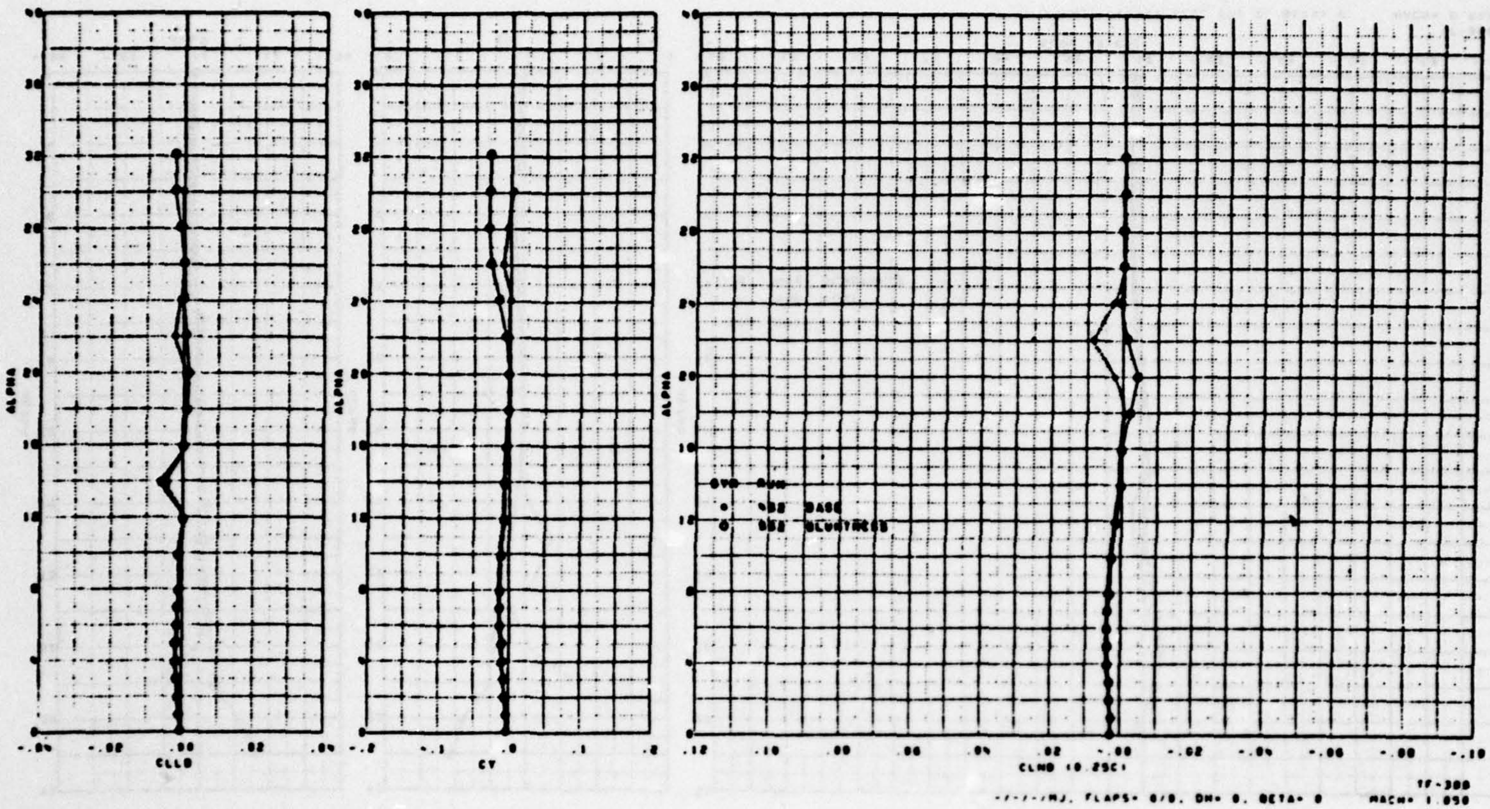


Figure 423. F-5F Effect of Nose Bluntness at Zero Sideslip, M = 1.05

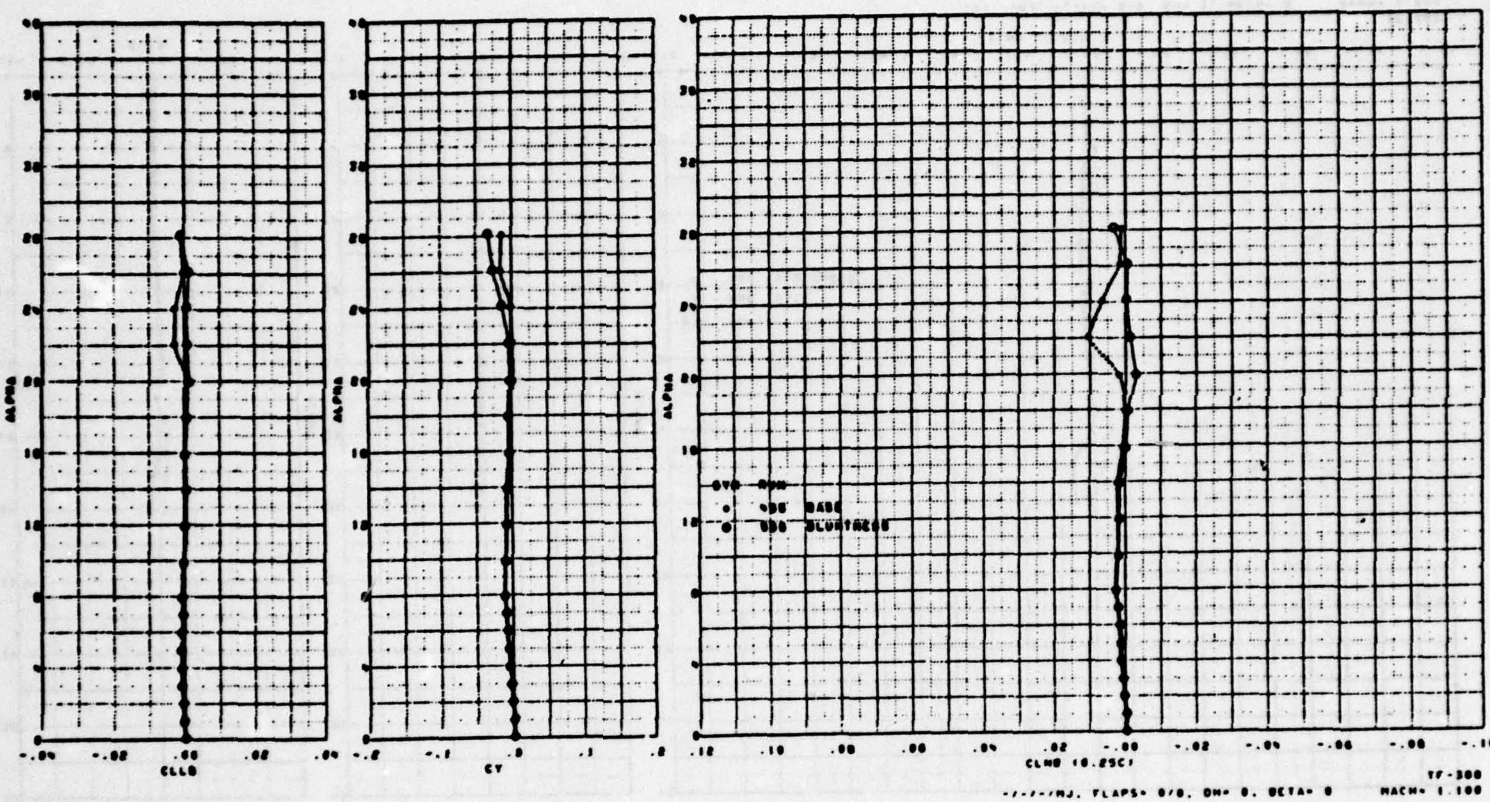


Figure 424. F-5F Effect of Nose Bluntness at Zero Sideslip, M = 1.1

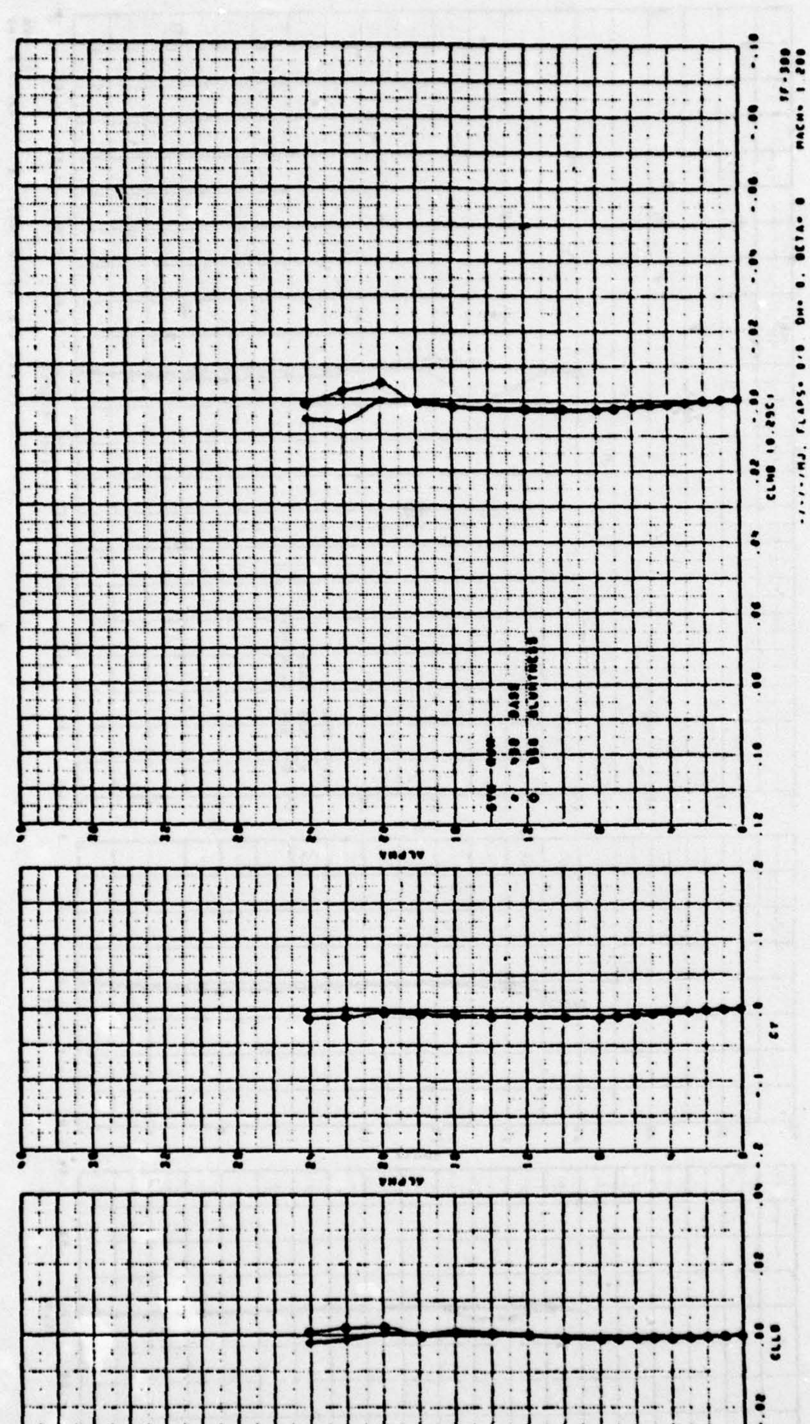


Figure 425. F-5F Effect of Nose Bluntness at Zero Sideslip, M = 1.2

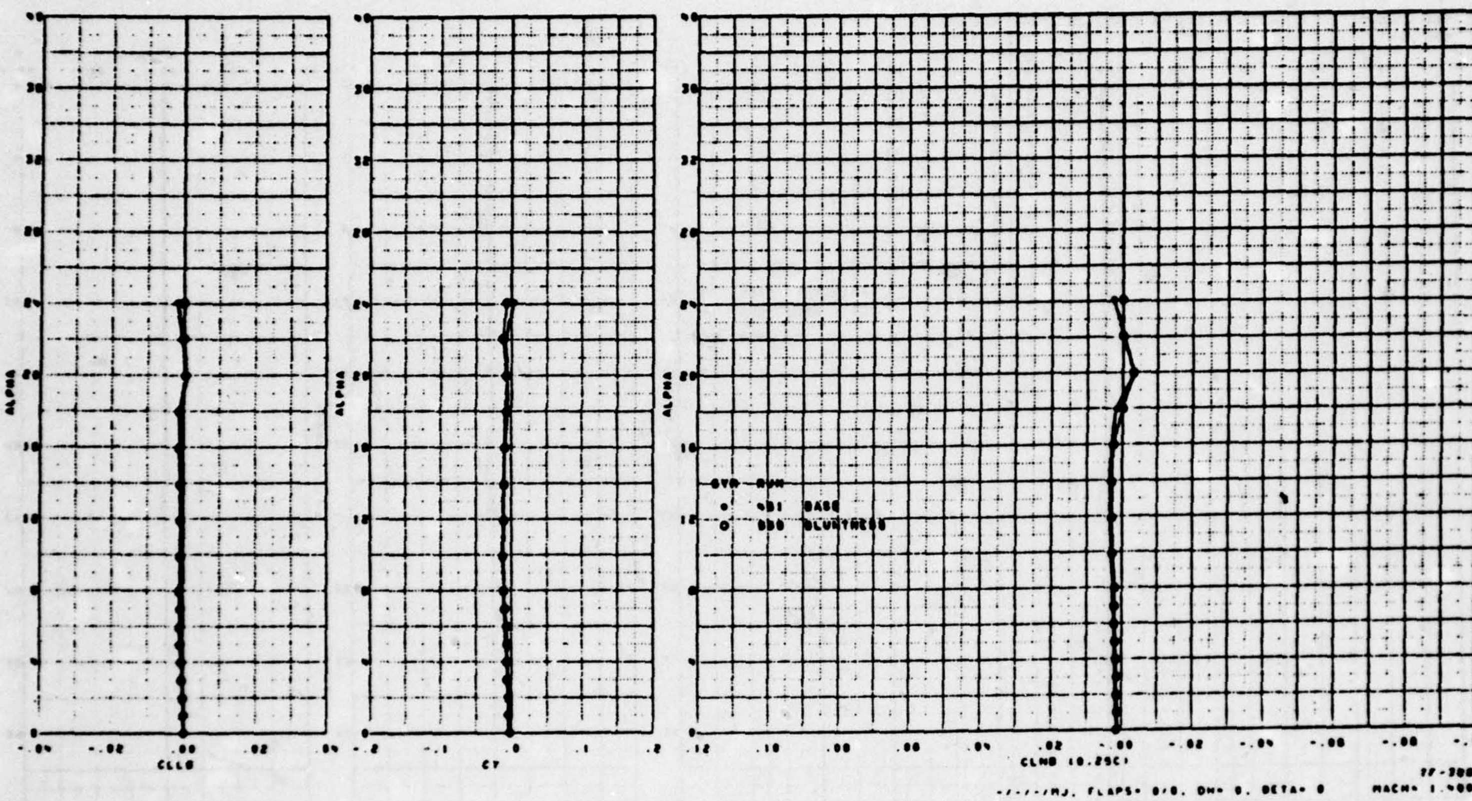


Figure 426. F-5F Effect of Nose Bluntness at Zero Sideslip, M = 1.4

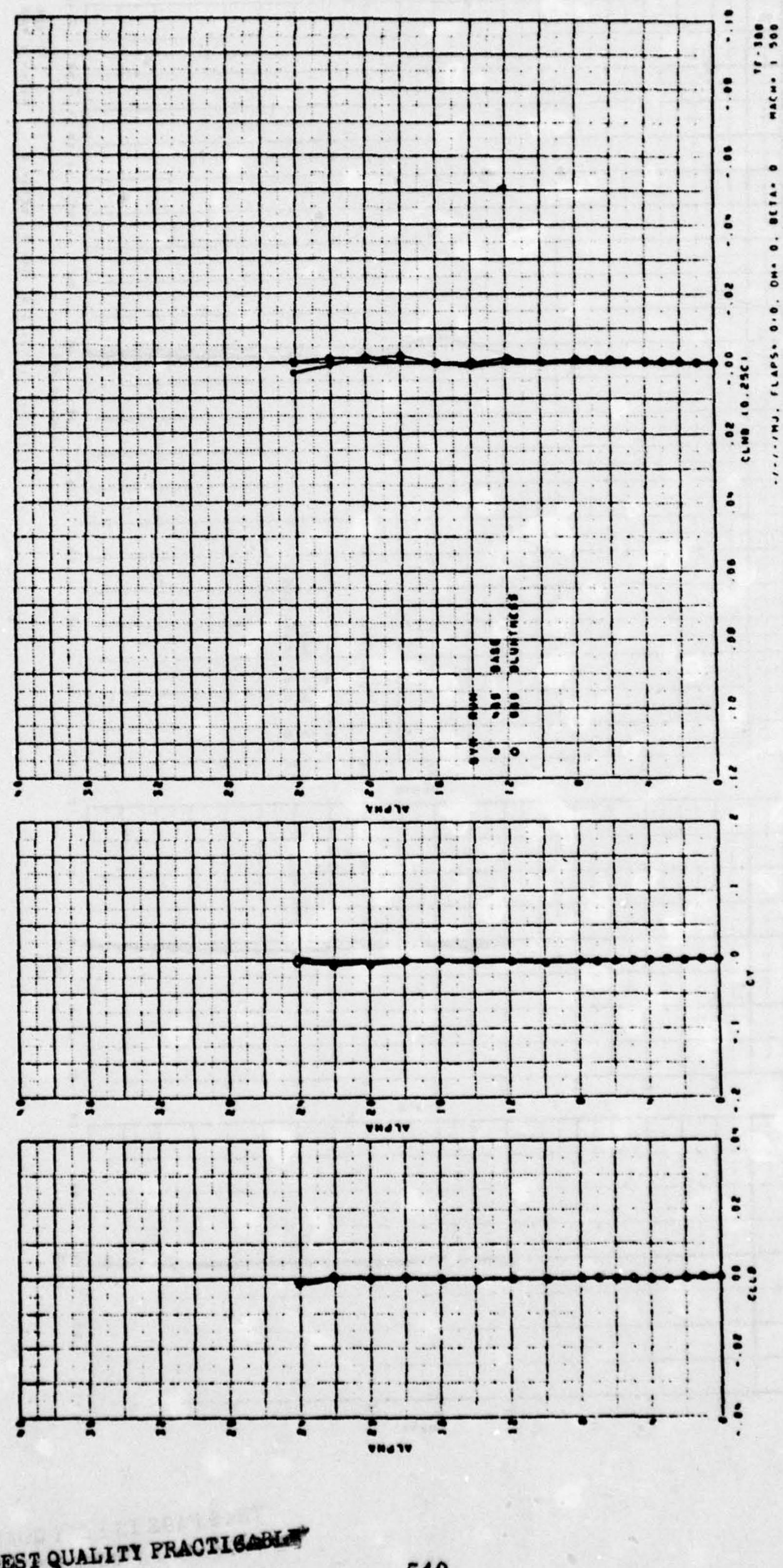


Figure 427. F-5F Effect of Nose Bluntness at Zero Sideslip, M = 1.5

AIRCRAFT	P530	REFERENCE	60

TEST REPORT

NOR 72-063 — Data Report of 0.025 Scale P530 Force Model Transonic and Supersonic Wind Tunnel Test

W. P. Rehm — Volume I - VII

REPORT SUMMARY

This report presents force and moment coefficient plotted data for a transonic and supersonic wind tunnel test of a 0.025 scale model of P530 airplane. The test program was conducted during the period 14 November 1970 to 31 July 1971.

The objectives of the test were to obtain:

1. Effect of fuselage glove
2. Effect of wing LEX
3. Wing leading edge flap effectiveness
4. Wing trailing edge flap effectiveness
5. Aileron effectiveness
6. Effect of asymmetric horizontal tail deflection
7. Horizontal tail effectiveness
8. Effect of asymmetric vertical tail
9. Effect of vertical tail planforms
10. Effect of vertical tail cant angle
11. Effect of vertical tail contour
12. Rudder effectiveness
13. Effect of speedbrakes
14. Flow visualization - oil flow study
15. Wing buffet on-set

TEST CONDITIONS

Mach No. = 0.4 to 1.5

R.N./Foot = 8 to 10 x 10^6

A.O.A. Range = Various

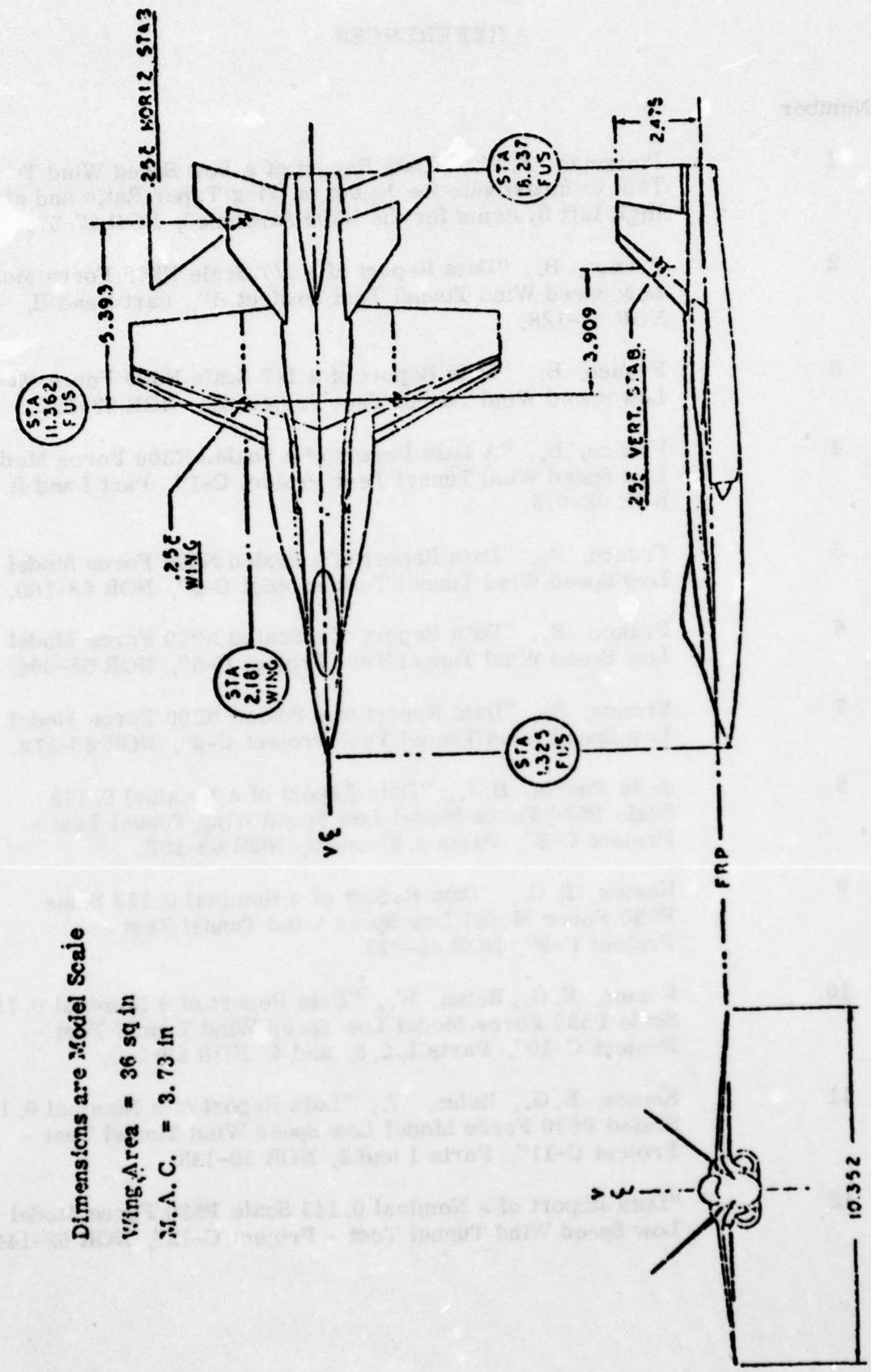
Sideslip Range = Various

AIRCRAFT CONFIGURATION

A basic model three view is shown in Figure 428.

CONFIGURATION CHANGES

None



Dimensions are Model Scale

Wing Area = 36 sq in

M.A.C. = 3.73 in

Figure 428. General Three View

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